NORTH CAROLINA
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
R. BRUCE ETHERIDGE, DIRECTOR

DIVISION OF MINERAL RESOURCES
JASPER L. STUCKEY, STATE GEOLOGIST

BULLETIN NUMBER 49

MICA DEPOSITS OF THE FRANKLIN-SYLVA DISTRICT, NORTH CAROLINA

BY
J. C. OLSON
AND OTHERS

PREPARED BY GEOLOGICAL SURVEY, U. S. DEPARTMENT OF THE INTERIOR
IN COOPERATION WITH THE
NORTH CAROLINA DEPARTMENT OF CONSERVATION AND DEVELOPMENT

RALEIGH
1946

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CONTENTS

CONTENTS—CONTINUED

CONTENTS—CONTINUED

Page

ILLUSTRATIONS

FIGURES

PLATES

LETTER OF TRANSMITTAL

Raleigh, North Carolina
March 9, 1946

To His Excellency, HON. R. GREGG CHERRY,
Governor of North Carolina.

SIR:

I have the honor to submit herewith, manuscript for publication as Bulletin 49, "Mica Deposits of the Franklin-Sylva District, North Carolina," by J. C. Olson and others.

From 1900 through 1940 North Carolina produced 60 percent of all the mica mined in the United States. The value of sheet mica produced in North Carolina in 1944 was 480 percent greater than that produced in 1941.

The Franklin-Sylva district ranks second in total production among the mica mining areas of the Southeastern states and supplies approximately 20 percent of North Carolina's output. It is believed that the information contained in this report will be of value to the mining industry of the area covered.

Respectfully submitted,

R. BRUCE ETHERIDGE,
Director.

PREFACE

This report entitled "Mica Deposits of the Franklin-Sylva District, North Carolina" has been prepared cooperatively by the U. S. Geological Survey and the N. C. Department of Conservation and Development. It represents the work of twelve geologists, all of whom are properly credited either in the text or on the maps of the report.

This report is a companion volume to Bulletin 43, "Economic Geology of the Spruce Pine District, North Carolina." These two reports, Bulletins 43 and 49, cover the major mica producing areas of North Carolina. While the Spruce Pine and Franklin-Sylva districts represent the most important of the State with respect to the volume and value of mica produced, there are several others of considerable importance. Most of these have been studied during the cooperative program and are being described in an over-all report being prepared for publication by the United States Geological Survey.

JASPER L. STUCKEY,
State Geologist.

MICA DEPOSITS OF THE FRANKLIN-SYLVA DISTRICT, NORTH CAROLINA

GENERAL SUMMARY

By J. C. Olson

ABSTRACT

The Franklin-Sylva district ranks second in total mica production among the mining areas of the Southeastern states. It is underlain almost wholly by metamorphic rocks that include mica, hornblende, garnet, and kyanite gneisses. The majority of the mica-bearing pegmatites cut across the foliation of the older rocks and were probably emplaced in fractures. Some of the bodies are more than 100 feet thick, but most are 5 to 15 feet thick. The plunges of pegmatite bodies are not consistent throughout the district.

Mining is for mica almost exclusively, although feldspar has been the principal product of at least four mines. The heavy demand for mica during the war years has resulted in increased mining activity and made the time opportune for detailed study of the deposits. Large-scale maps have been prepared of many mica mines.

The mica is commonly localized into certain parts of the pegmatite bodies, called "shoots" or "streaks," which are mined selectively. The position of the mica shoots varies among the different pegmatites. The mica blocks may be found clustered near quartz cores that make up a third or a fourth of the total thickness of some pegmatite bodies, near walls or inclusions, in sporadic "pockets", or disseminated throughout the pegmatite body. Granite and pegmatite occur together in five composite dikes.

The quality of mica has been an increasingly important factor in all mica mining. Wartime demands have led to selective mining of the high-quality, flat, clear, easily-split sheet mica in sizes larger than 1 square inch. Much of the Franklin-Sylva mica is clear and of rum (light-brown) or ruby color. Dark rum (brown) and green mica that is partly stained predominates along the southeast edge of the district and in the less-productive Cashiers district ten miles to the southeast.

In the average sheet-mica mining operation, from 5 to 15 tons of rock are moved daily, yielding from a few to 500 pounds of block mica. Total mica in the rock mined probably ranges from 3 to 10 percent at most good mica mines, but if mine scrap and mica too small to be recovered are excluded, the remaining block mica probably averages only one to four percent of the rock mined. Feldspar mining has seldom been profitable in the district, owing to the high cost of transportation to the nearest market at Spruce Pine, but coarse potash feldspar occurs in some of the pegmatites.

It is estimated that the Franklin-Sylva district has supplied nearly 20 percent of North Carolina's output of mica during the period 1920 to 1940. About half of this was from the Big Ridge mine. The average annual output of the district for the years 1920-40 is estimated as nearly 126,000 pounds of sheet and punch mica. There is no geologic reason why this rate of production should not remain approximately the same under similar economic conditions. The rate of production attained during the war years 1942-44 is the best index of the district's potentialities under more intensive development.

INTRODUCTION

The importance of mica to the nation during the war has resulted in great expansion of mica mining in the Franklin-Sylva district as well as other domestic mica-producing areas. Many old mica mines have been reopened and new prospects developed. The intensive mining activity has exposed many pegmatites and made the time opportune for detailed geologic study of the deposits. Detailed mapping of mines and geologic study of the mica occurrences have been very useful both in the evaluation of specific deposits and as a guide in their development. The geologic work on which this report is based was designed primarily for immediate use as a guide to mining operations, but the data obtained on the geology and extent of mine workings should be of practical value in the future as well.

To facilitate the production of domestic mica, the Colonial Mica Corporation was established in 1942 as an agent of Metals Reserve Company. During the period of great demand and unusually high prices, the Colonial Mica Corporation became the sole purchasing agent for high-quality sheet and punch mica in this country. The Corporation has aided miners by supplying them equipment at nominal rentals, by advancing funds to be used in opening promising mines or prospects, and by providing men experienced in the mica industry to advise operators on the mining and preparation of mica.

GEOGRAPHY

The Franklin-Sylva pegmatite district, in southwestern North Carolina, includes parts of Macon, Jackson, Haywood, and Transylvania counties. (See fig. 1.) The southwest boundary of the district is arbitrarily taken as the line between Macon and Clay counties, but scattered deposits have been mined in Clay

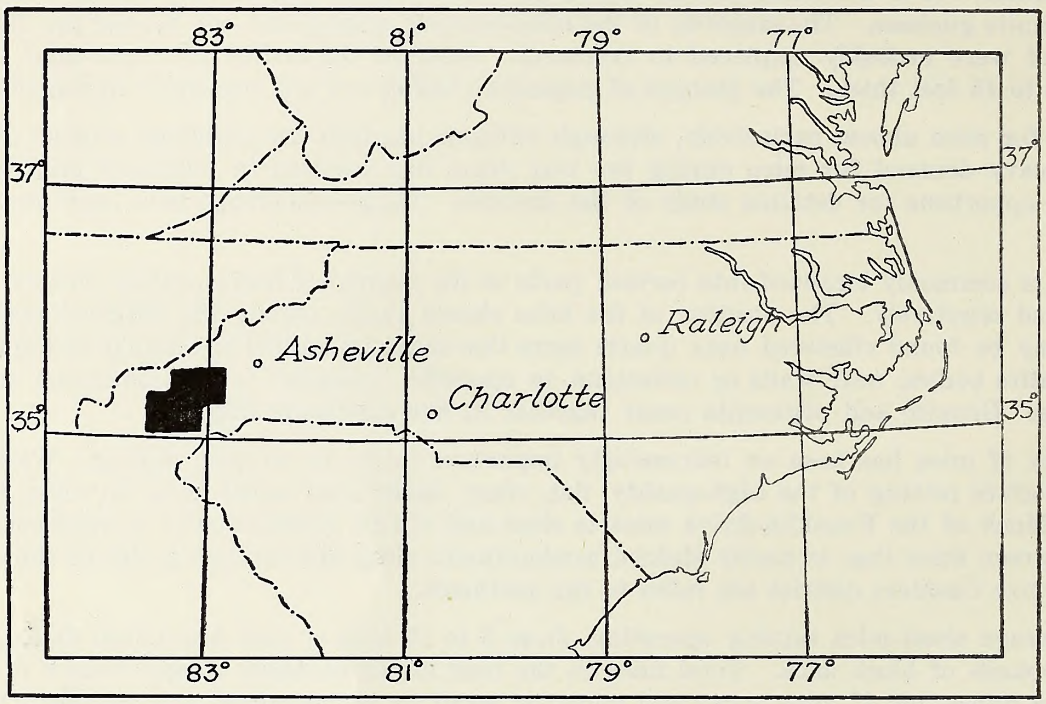
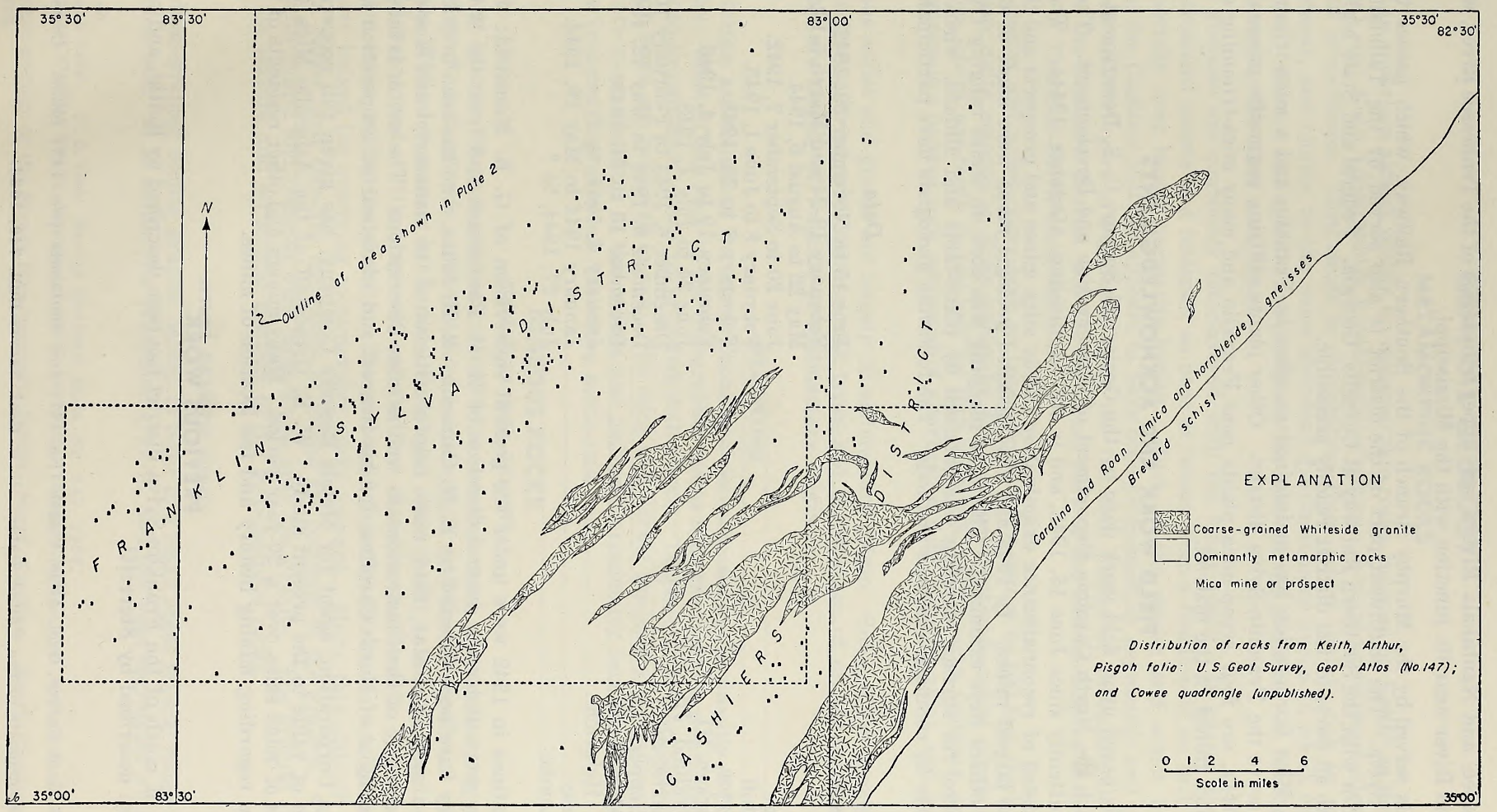


FIG. 1.—INDEX MAP SHOWING LOCATION OF THE FRANKLIN-SYLVA DISTRICT, N. C.

County and northeast Georgia. The Franklin-Sylva district is a northeast trending belt 14 miles wide and 45 miles long, in which hundreds of pegmatites have been mined or prospected for mica. This district ranks second in total mica output among the mining areas of the Southern Appalachian region; feldspar, kaolin, corundum, garnet, dunite, copper, and vermiculite have also been mined.

The Cashiers district, another area in which many mica-bearing pegmatites occur, lies southeast of the Franklin-Sylva district. In a few places the two districts almost join, as shown in plate 1, but elsewhere they are separated by a relatively barren area in which very few mica-bearing pegmatites occur. This report deals primarily with the Franklin-Sylva district, but also contains a discussion of its geologic relations to the less productive Cashiers district. The locations of mines in the Franklin-Sylva district are shown in plate 2.

The Franklin-Sylva district is in the Appalachian Mountain region, among transverse ridges that lie between the Blue Ridge on the southeast and the Smoky Mountains on the northwest. Altitudes range from 1,950 feet on the Tuckasegee River to 6,540 feet on Richland Balsam. Much of the district is mountainous, but basin-like areas one to four miles wide along the principal rivers are characterized by gently rolling topography. The rocks are commonly weathered, in places to depths of more than 100 feet. Hard outcrops are most abundant on the steeper slopes. The principal streams, the Pigeon, French Broad, Tuckase-



MAP SHOWING RELATION BETWEEN FRANKLIN-SYLVA AND CASHIERS DISTRICTS, NORTH CAROLINA.

gee, Little Tennessee, and Nantahala Rivers, are upper tributaries of the Tennessee River, which flows westward into the Ohio River near its junction with the Mississippi.

The district is served by the Murphy Branch of the Southern Railway, which passes through Canton, Waynesville, and Sylva. The southwest part of the district is also served by the Tallulah Falls Railway, connecting Franklin with the Southern Railway at Cornelia, Georgia. Federal and State highways and many county roads make all parts of the district readily accessible.

The Colonial Mica Corporation has maintained an office in Franklin and a mica-trimming and buying shop in Sylva to serve the Franklin-Sylva district. Other plants utilizing pegmatite minerals at the present time (October 1944), are four scrap-mica plants near Franklin and many mica-trimming shops for preparation of sheet mica mined in the district.

FIELD WORK AND ACKNOWLEDGMENTS

This report is based upon field work done by the Geological Survey, U. S. Department of the Interior, in cooperation with the North Carolina Department of Conservation and Development. The work has been carried on intermittently since June 15, 1942, and is still continuing (October 1944). The investigations during 1942 consisted of reconnaissance examination of 254 mica mines and prospects and the detailed mapping of two of the largest mines. In 1943 and 1944 detailed geologic maps were made of 64 individual deposits, and many others were examined. The mine mapping was done on scales ranging from 20 to 50 feet to the inch. Control for surface mapping was obtained by plane-table and alidade, whereas underground surveying was done by compass and tape methods. The following geologists have participated in this work:

	Date
J. C. Olson	June 15 to November 30, 1942. February 19-24 and March 5-10, 1943. May 23 to August 6, 1944.
J. J. Page	June 20 to September 7, 1942.
W. C. Stoll	February 8 to June 1, 1943.
J. J. Norton	February 8 to 20, 1943.
J. M. Parker, III	February 19 to July 4, 1943.
V. C. Fryklund, Jr.	June 24 to July 4, 1943.
D. M. Larrabee	December 6, 1943 to February 10, 1944.
M. R. Klepper	December 6, 1943 to May 12, 1944.
W. B. Allen	December 13 to 31, 1943.
E. Wm. Heinrich	January 4, 1944, to ?
L. C. Pray	January 1944 to May 19, 1944.
R. W. Lemke	July 27, 1944, to ?

The investigations in 1942 were under the general supervision of G. R. Mansfield; during 1943 and most of 1944 they were under the general direction of H. M. Bannerman and from the latter part of 1944 to the present they have been directed by E. N. Cameron. R. H. Jahns, who has been in charge of pegmatite studies in the Southeast since May, 1944, made helpful criticism of the manuscript and illustrations. E. Wm. Heinrich prepared many of the illustrations as well as mine descriptions. The writer is indebted to Dr. J. L. Stuckey, State Geologist of North Carolina, for his interest and wholehearted cooperation in the work.

Colonial Mica Corporation, agent for Metals Reserve Company, has given full cooperation as well as much information of value to the present study. W. E. Grindstaff of the Asheville Mica Company kindly furnished records of mica sales over a 20-year yeriod. Many miners and other residents of the district have given information regarding mining history and the location of mines.

PREVIOUS WORK

The geology of much of the Franklin-Sylva district has been described by Keith[1], and many of the mica deposits have been described by Sterrett[2].

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[1] Keith, Arthur, U. S. Geol. Survey, Geol. Atlas, Pisgah (No. 147) and Nantahala (No. 143) folios. Cowee quadrangle (unpublished.)

[2] Sterrett, D. B., Mica deposits of the United States: U. S. Geol. Survey Bull. 740, 1923.

GENERAL GEOLOGY

METAMORPHIC ROCKS

The district is underlain almost wholly by metamorphic rocks, mapped by Keith[3] as the Carolina (dominantly micaceous) and Roan (dominantly hornblendic) gneisses. Several varieties of mica gneiss are interlayered in various proportions. They range in composition from schist that is rich in muscovite, with a little quartz, feldspar, and biotite, to the more abundant quartzose mica gneiss in which the mica flakes are sparsely distributed. Garnet and kyanite are prominent in some of the gneisses. A few fine-grained granitoid layers occur among the other rock types.

Feldspathic gneisses are commonly interlayered with the other rocks. In places the schistose rocks contain much introduced quartz and feldspar, as pods or lenses from a fraction of an inch to several inches in thickness, especially near larger pegmatite bodies. Much of the gneiss and schist in the vicinity of granite bodies in the Cashiers district appears to have been permeated by pegmatitic and granitic solutions. Small pods, lenses, and stringers of pegmatite along the foliation planes of metamorphic rocks are much more common in the Cashiers district and the southeast part of the Franklin-Sylva district than they are in the main belt of Franklin-Sylva mica deposits.

Hornblende gneiss and schist occur both as layers from a few inches to 100 feet thick in the micaceous rocks and as larger units mapped as Roan gneiss by Keith. The hornblende schist consists mostly of black hornblende needles, about one-tenth to one-half an inch in length, with quartz, feldspar, and a little biotite. The hornblende gneiss is a banded rock composed of alternating dark (hornblendic) and light (quartz-feldspar) layers.

The micaceous schist and gneiss are largely of sedimentary origin. Some of the hornblendic rocks may be sills, but their interlayering with diverse rock types and the absence of cross-cutting relations suggest that they probably are largely of volcanic or sedimentary origin.

WEATHERING

The best outcrops are found on the steep slopes, and are composed predominantly of mica-garnet gneiss and kyanite gneiss. Most of the rock in the topographic basins near the rivers is weathered deeply, yielding light-red to reddish-brown and brown to brownish-yellow soils. In general the hornblendic rocks yield red clay soils, although some are yellowish brown. The mica and garnet gneisses yield yellow, brown, and gray soils. Red soils are more plentiful in the valleys and plateaus, presumably because the weathering is more advanced and the iron-bearing minerals therefore more oxidized.

IGNEOUS ROCKS

COARSE-GRAINED GRANITE

Coarse-grained granite, in part pegmatitic, underlies areas as much as 18 miles long and 5 miles wide in the Cashiers district, and extends southwestward into Georgia and South Carolina. (See pl. 1.) This rock was called the Whiteside granite by Keith[4]. It is light colored and is composed of quartz, orthoclase and plagioclase feldspars, and a little muscovite and biotite. Patches and streaks of coarser pegmatite of similar composition occur within the granite. The principal granitic intrusions are thick sill-like bodies that appear to have bulged the overlying metamorphic rocks upward. Many thin sills of granite occur in the adjacent mica gneiss, and slab-like inclusions of gneiss are common in the granite. The gneisses have been permeated with quartz and feldspar over large areas near the granite. The granite resembles that at Spruce Pine[5], in its texture and structural relation to the metamorphic rocks.

OTHER GRANITIC BODIES

Fine- to medium-grained biotite granite occurs in large and small areas several miles northwest of the Franklin-Sylva mica belt. It is unlike the Whiteside granite, and has been correlated with the Cranberry

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[3] Keith, Arthur, op. cit.
[4] Keith, Arthur, Pisgah folio: U. S. Geol. Survey Geologic Atlas, No. 147, 1907.
[5] Hunter, C. E., Residual alaskite kaolin deposits of North Carolina: Amer. Ceramic Soc. Bull., vol. 19, no. 3, pp. 98-103, March 1940.
Olson, J. C., Economic geology of the Spruce Pine pegmatite district, North Carolina: North Carolina Dept. Cons. and Devel. Bull. 43, 1944.

granite by Keith[6]. Its largest area of outcrop is north and west of Canton, but smaller bodies occur in the Nantahala Mountains and north and west of Franklin.

Granitic dikes are sparsely distributed in the district as a whole, but are most plentiful in the northeast and central part. Most of them are between three inches and six feet thick, and are composed of fine-grained feldspar and quartz, fine muscovite and biotite flakes that are commonly parallel to one another, and scattered small garnets. Porphyritic varieties have medium- to coarse-grained feldspar, quartz, or biotite, in a finer-grained matrix. Fine-grained, slightly foliated granite dikes, eight inches to five feet thick, are best exposed at the Sally Reed, Bee Tree No. 1, Rock, Diller Bryson, and Island Ford mines. Most of them cut the pegmatite bodies and are doubtless younger, although the difference in age may not be great. Aplite dikes are cut by pegmatite at the Iotla-Bowers mine. They are two feet thick on the average, uniform in grain size, and composed of an intimate mixture of quartz and kaolinized feldspar.

Granite and pegmatite occur together and are genetically related in the composite dikes at the Tilley, Roarenhole, Moss, Borrows Cut, and Big Ridge pegmatites. The granite and the pegmatite in these unusual deposits were formed at essentially the same time. The granite, described on p. 10, is fine- to medium-grained and is distinctly different from the coarse-grained Whiteside granite.

DUNITE

Small bodies of ultrabasic rocks occur in the district. They are generally elliptical in plan, having a maximum width of as much as 0.4 mile, and a maximum length of more than 2 miles[7]. They are most extensive in the Webster-Addie-Balsam area of Jackson County. As Hunter points out, the individual bodies in the Webster-Addie area are arranged along the circumference of a circle, forming a discontinuous ring-dike. Numerous isolated dunite bodies occur in other parts of the district. Dunite, consisting almost entirely of olivine, and an impure soapstone containing amphiboles are the most common varieties. The dark, rocky ground where they occur supports little vegetation. These rocks were observed by Keith[8] to cut across the Roan gneiss.

STRUCTURE

FOLDS

The planes of schistosity have been folded on a large and small scale. The schistosity strikes rather uniformly northeast over much of the district, but local deflections to a northwest strike are not uncommon. Almost all the foliation in the Franklin-Sylva district dips at an angle greater than 45 degrees and much is approximately vertical. In the Cashiers district the dips are less steep on the average, many of them less than 45 degrees. The decrease of dip southeastward is similar to that in the Spruce Pine district 100 miles northeast.

FRACTURES

Fracturing of the metamorphic rocks has an important bearing on the distribution of commercial mica because fractures formed prior to pegmatite introduction guided the incoming solutions and, in pegmatite already solidified, rock movements crush or "rule" the mica. Faults and joints are numerous in the Franklin-Sylva district, but the faults observed are probably not of very great displacement. Some of the fractures have been filled with quartz or pegmatite.

The general character of the fracturing may be seen in a road cut about 200 feet long on Savannah Creek. There the strike of the foliation of the gneiss is nearly uniform in the cut, but the dip changes abruptly within short distances because of close folding. Four parallel pegmatite bodies one to two feet thick cut the gneiss. They dip steeply, have sharp walls, and presumably fill fractures. A gently-dipping normal fault, along which drag is evident, cuts the gneiss. This fault has been filled with quartz, but other small faults exposed have no filling. In general this example is thought to typify the structure of the district. Steeply-dipping, parallel pegmatite bodies, emplaced in fractures, cut the country rocks. Later

[6] Keith, Arthur, op. cit.
[7] Hunter, C. E., Forsterite olivine deposits of North Carolina and Georgia: North Carolina Dept. Cons. and Devel. Bull. 41, 1941.
[8] Keith, Arthur, op. cit., p. 3.

faults cut wall rocks and pegmatite. These post-pegmatite faults are numerous in the Savannah section of Jackson County, but they occur throughout the district. They have effected much ruling and bending of the mica books.

Many contact relations indicate that pre-pegmatite faults were channels for incoming solutions. Sharp changes in strike of foliation a few inches to three feet from the pegmatite body may be the result of drag along a fault prior to the introduction of pegmatite. Evidence of such drag was observed at the R. T. Bryson, Poll Miller, Winecoff, Dills, Lin Cove, Wilkes, and other mines. At the Jack Knob mine, for example, the foliation of the biotite gneiss at the contact is very nearly parallel with the walls of the pegmatite body, but it changes two feet from the contact from a northwest strike to nearly due east, through an angle greater than 90 degrees.

Fractures in the metamorphic rocks undoubtedly controlled the disposition of many of the pegmatites. This control is indicated by the parallelism of tabular discordant pegmatite bodies, for example those in the Panther Knob area of Jackson County and those in a belt extending three miles northwest from the town of Franklin. Abrupt bends in cross-cutting pegmatite bodies, and offshoots or apophyses having diverse attitudes, provide additional evidence of the existence of a pre-pegmatite fracture pattern.

Contacts between pegmatite and wall rock are comparatively sharp in the nearly tabular pegmatite bodies that appear to have formed in fractures. Not all the pegmatite bodies are tabular or so sharply defined, however, for some have very irregular walls. Notable examples of irregular-walled pegmatite bodies are the Burr Knob, Iotla-Bradley, Gurney Clay, Shepherd Knob, and Dillard mines.

The effect of pre-pegmatite fracturing of the rocks is more pronounced in the Franklin-Sylva district than it is to the southeast in the Cashiers district. The invasion of the granitic magma near Cashiers was accompanied by profound "soaking" of the metamorphic rocks, and schistosity was most important as a guide to incoming pegmatitic and granitic solutions.

PEGMATITES

SIZE AND SHAPE

The pegmatite bodies range from lenses a fraction of an inch thick to great masses such as the Big Flint, Iotla-Bradley, Shepherd Knob (each 100 feet or more thick), Lin McCall (50 feet), Roda (about 150 feet), Gradin (65 feet), and Gurney Clay (50-200 feet). Thicknesses vary, but some pegmatite dikes that appear to have formed in fractures are nearly uniform in thickness for 100 feet or more along the strike. Many pegmatite bodies are lenticular, and thin rapidly along the strike. For example, the thickness of the "Little Vein" at the Welch mine diminishes from 4 feet to 5 inches within a strike distance of 20 feet. The quartz core and associated mica are present where the pegmatite body is 4 feet thick, but not where it is only 5 inches thick.

The pegmatite bodies have a variety of shapes. Some are tabular or sheet-like (Frady); some are elongate lenses (Iotla-Bowers); some are very irregular (Shepherd Knob, Dillard). Some vein-like quartzose bodies are thin and have irregular gradational contacts (Rock, Cedarcliff, and Bee Tree No. 1); others are merely small lenses, some without visible connection, disposed along a plane or in imbricate arrangement in the gneiss or schist. At the Island Ford mine, for example, lenses one to three feet thick were mined along a thin, conformable layer of gneiss that contained many pods and stringers of pegmatite material. Books of mica have been found here in the wall rocks of gneiss.

STRUCTURE

Most of the pegmatite bodies dip steeply, and the majority cut across the foliation of their wall rocks. Some strike parallel to the foliation, but transect it in dip; this type is particularly common in an area of several square miles northwest of Franklin. "Rolls", or abrupt changes in dip, are common.

The pegmatite and associated granite body at the Big Ridge mine (see description, pp. 28-32) are arch-shaped, as is the pegmatite body at the Cox mine (pp. 32-34). A somewhat similar bend occurs in the Shepherd Knob pegmatite (described on pp. 48-50). In all these deposits, at least one of the limbs of the arch crosscuts the wall-rock foliation. The arched shape is apparently due to the arrangement of intersecting

fractures that guided the solutions, and not to subsequent folding of both pegmatite and wall rock or to the introduction of solutions conformably along the crest of an anticlinal fold in the gneiss.

The plunges of pegmatite bodies are not consistent throughout the district. Many of the tabular bodies have been mined directly down the dip, whereas in the Spruce Pine district to the northeast the predominant plunge of pegmatite bodies is toward the south or southwest at angles of 20 to 40 degrees. Plunges other than directly down dip have been established for at least a dozen Franklin-Sylva pegmatite bodies, or parts of the bodies, including the following: Baird (one of several pegmatites on property), plunges 30° SE. to horizontal; Beasley No. 2, 35° SE.; Bowers, 45° NW.; Buoy No. 1, 20° NW. to 60° NW.; Buoy No. 2, 25° NW.; Cox, 10° S68°W.; Lyle Knob, 25° W.; May, 25° N45°W.; Moody, 60° S55°W.; Poll Miller, 24° NE. to 40°NE.; Raby, 47° S82°E.; Shepherd Knob, 15°N. to 20°N. The diversity of direction suggests that such plunging structures are related to local rather than regional structural elements.

WALL-ROCK ALTERATION

The metamorphic wall rocks or inclusions may be altered by pegmatitic solutions both through the coarsening of mineral grains in the gneiss or schist, and through the addition of pegmatite minerals. Small lenses of quartz or feldspar are common in wall rocks, especially in the more schistose varieties. Pyrite and pyrrhotite occur in wall rocks, particularly adjacent to certain quartzose pegmatites. Examples of the coarsening of wall-rock minerals are numerous. At the Shepherd Knob mine, for example, the rocks near the pegmatite are markedly different from the more normal country rock exposed in adits 200 to 300 feet away. There are several types of wall-rock alteration at the Shepherd Knob: (1) mica books as much as 1.5 inches in diameter are present in the wall rocks and inclusions, generally with their cleavages perpendicular to the foliation and enclosing many small garnets; (2) the wall rock has been permeated with pegmatitic feldspar and quartz; and (3) the mica gneiss has become enriched in mica and thereby changed to mica schist. The first two types of alteration yield a rock that is gradational between true pegmatite and wall rock.

MINERALOGY

The pegmatities of the Franklin-Sylva and Cashiers districts contain microcline and plagioclase feldspars, quartz, muscovite, biotite, garnet, allanite, apatite, magnetite, tourmaline, ankerite, beryl, samarskite, hedenbergite, and such sulfide minerals as pyrrhotite, pyrite, and chalcopyrite.

Most of the quartz in the Franklin-Sylva district is white or sugary. A little is gray or smoky, but gray quartz is more abundant in the Cashiers pegmatite belt to the southeast. Veins of white quartz containing a little ilmenite and iron oxide are common in all the country rocks. They range from a fraction of an inch to about four feet in thickness.

Potash feldspar (microcline) is the dominant feldspar in many of the pegmatites, but plagioclase predominates in most mica-bearing streaks. It is often difficult to distinguish feldspars because they are almost completely altered to kaolin in the surficial portions of many pegmatites. Graphic intergrowths of quartz and feldspar (graphic granite) are rare.

Biotite is an abundant pegmatite mineral, and much of it is intergrown with muscovite. In some pegmatites it occurs as long strips—as much as five feet long at the Putman mine. Biotite probably constitutes at least a third of the mica at the Big Ridge mine, and at the J. Radeker mine it appears to be 1½ to 2 times as abundant as muscovite. It is exceptionally plentiful at the Ray Cove mine, in blocks as large as 6 x 8 x ¾ inches. Perhaps its abundance here is due partly to interaction between the pegmatite and hornblende-garnet gneiss, which forms the wall rock at this mine but at very few others. The pegmatite at the Sheep Mountain mine, whose wall rock is quartz-biotite gneiss, is exceptional in having a large proportion of both biotite and muscovite. (See description, pp. 47-48.) Some of the biotite strips occur near the margins of massive quartz bodies—for example in the Moody mine (p. 42) and the Big Flint (pp. 26-28).

Garnet is sparsely distributed in the pegmatites, but it occurs in 2-inch crystals at the Blanton prospect. Apatite and allanite occur in a few pegmatites. Black tourmaline is found at the Painter mine, and at the Slagle mine at Rainbow Springs. Black and pink tourmaline, samarskite, and beryl have been reported by J. H. Pratt[9] from the Grimshawe mine in the Cashiers district. There is little or no beryl in the Franklin-Sylva district, but some gem material has been mined in the Cashiers district.

[9] Sterrett, D. B., op. cit., p. 216.

Sulfide minerals are widely distributed, and commonly occur in quartzose pegmatites or in massive quartz bodies in larger feldspathic pegmatites. Pyrrhotite and pyrite are plentiful in the quartzose pegmatites at the Bee Tree No. 1, Rock, Cedarcliff, and Shiny mines. Chalcopyrite and bornite occur with the more common pyrrhotite and pyrite at the "C" mine, and masses of pyrrhotite with chalcopyrite, weighing as much as a half-pound, occur at the Thorn Mountain mine. Veinlets of sulfide minerals at the Tilley mine cut all the other minerals. The sulfide minerals appear to be among the last to form in the sequence of pegmatite minerals.

MINERAL DISTRIBUTION

The economic value of a pegmatite body depends to a great extent upon the degree to which the minerals, particularly mica, are localized or concentrated into "shoots" or "streaks". Pegmatites in the Franklin-Sylva district in which the minerals are distributed more or less uniformly seldom can be mined profitably for sheet mica. Mineral proportions vary along the strike or down the dip of a pegmatite body. The mining is usually done in parts of the pegmatite bodies where the valuable minerals are most conspicuously localized.

QUARTZ CORES

Massive quartz forms the central part, or core, of many pegmatite bodies, commonly comprising a fourth to a half of the total thickness of a dike. The quartz mass at the Big Flint mine is as much as 65 feet thick (see pl. 6); that at the Shepherd Knob mine is at least 20 feet thick (pl. 17). The quartz bodies have the form of irregular lenses, somewhat elongate in the direction of plunge of the pegmatite body. In shape they range from attenuated, almost tabular lenses (Poll Miller mine, pls. 14 and 15; Turkey Nest and Lyle Cut mines, pl. 19) to lenses with thickness nearly equal to strike length (Big Flint mine, pl. 6; Roda mine). Many are discontinuous and are distributed unevenly along the strike or plunge of the pegmatite body.

The thickest part of many of the quartz cores coincides with the thickest part of the enclosing pegmatite bodies and, in places, with abrupt bends in strike or dip of the pegmatites. The thick quartz mass at the Moody mine (pl. 13), for example, occurs in a segment of the pegmatite that trends N.60°E., whereas both east and west of this segment the strike is slightly north of west and the pegmatite is not so conspicuously zoned. Likewise the parts of the Moody pegmatite richest in mica, where the quartz is thickest, may coincide with a slight decrease in the dip of the pegmatite body. A quartz core in the thickest part of Iotla-Bowers pegmatite coincides with an abrupt change in strike of the footwall from N.60°W. to N.8°W. In general this dike dips steeply southwest and is practically homogeneous except for small scattered quartz pods and a slightly higher mica content along the footwall than in other parts. The deposit has been mined most intensively in a segment with a strike length of about 50 feet, in which the quartz core occurs.

The typical quartz core is thickest near the central part of its strike length. In places (Raby, Welch mines) the quartz cores end very bluntly in plunging noses. In other pegmatites the quartz cores thin gradually until so small that they become indistinguishable among the other grains in the pegmatite. Beyond its vanishing point the quartz core may be succeeded by or grade into another central zone that differs from the wall zones; for example, the quartz mass in the middle of the Beasley No. 2 pegmatite (pl. 5) disappears along the strike and is supplanted by a plagioclase-mica pegmatite that differs from the wall zones in containing much muscovite and biotite. At the Stillwell mine (pl. 18) the quartz core exposed at the base of the 123-foot New shaft grades southward into quartz-muscovite pegmatite ("burr rock"), and northward into quartz-feldspar pegmatite. At the Poll Miller mine (pls. 14 and 15, description on p. 46) the quartz core is supplanted to the southwest by a thick central rib of coarse blocky microcline, which in turn grades into medium-grained feldspar-quartz pegmatite. Block muscovite is abundant in the wall zones at the Poll Miller both where the central part of the dike is quartz and where it is coarse microcline.

"BURR ROCK"

Pegmatitic quartz containing many small (¼ to 1 inch), sub-parallel mica flakes is known locally as "burr rock". At the Shepherd Knob mine the "burr rock" appears to be a marginal phase of the large quartz core. At the Allman Cove mine (pl. 3), however, "burr rock" is more common than massive quartz, which is confined to small masses two or three feet thick near the west end of the mine. The bodies of "burr rock" range from an inch to a foot or more in thickness and are discontinuous. "Burr" streaks lie parallel to and within a few feet of each wall of the Allman Cove pegmatite, and another, near the middle, also follows the

east trend of this pegmatite; others have a northeasterly trend. Sheet mica occurs either in the "burr rock" or in the adjacent plagioclase. Much of the mica produced from the Miller mine was derived from "burr rock".

BORDER ZONES

Fine-grained border zones generally less than a foot thick are present along the walls of many pegmatite bodies. The border zones are mostly plagioclase and quartz, but also contain mica flakes ¼ to 1 inch in diameter and small garnets in some places. The cleavage planes of the mica flakes tend to be perpendicular to the contacts. The grain size increases inward from the walls.

FELDSPATHIC PEGMATITE

The parts of the pegmatite bodies other than the border zones and the massive quartz cores will be considered herein as "feldspathic pegmatite", inasmuch as feldspar is the predominant mineral except in rare varieties of quartzose pegmatite. Various kinds of feldspathic pegmatite may be distinguished according to the proportions of microcline, plagioclase, quartz, and other minerals. Numerous examples of feldspathic pegmatite are shown on the mine maps accompanying this report. It is possible in most pegmatite bodies to distinguish more than one type of feldspathic pegmatite, although this distinction is difficult when the feldspars are weathered. A common distinction is that made between plagioclase-quartz pegmatite and microcline-quartz pegmatite. The microcline-rich parts of the pegmatite bodies are generally in the interiors, whereas the plagioclase-rich parts tend to occur along the margins. Commercial muscovite is most abundant in the plagioclase-quartz type.

GRANITE IN PEGMATITE

Granite that forms a component part of the composite dikes at the Tilley, Moss, Borrows Cut, Roarenhole, and Big Ridge mines differs from the large granite bodies and granitic dikes described on previous pages. The granite at each of these five mines is a uniformly fine-grained mixture of oligoclase, quartz, and biotite. Although the rock contains very little potash feldspar, it will be referred to in this report by the miners' term "granite".

The composite dike exposed at the Moss (Adams) mine consists of a central granite body three feet thick, along each margin of which occurs a six-inch to two-foot thickness of fine-grained pegmatite. This dike is exposed discontinuously from the south end of the mine, where it is 1½ feet thick, to a point a third of a mile to the north on the Tuckasegee River. Most of the mining was done, however, within a strike distance of 800 feet; Sterrett[10] has described the pegmatite in the main workings. The pegmatitic zones consist in some places almost entirely of muscovite, in others of feldspar and some quartz. The contact between the pegmatite and the granite, according to Sterrett, is irregular and not sharply defined. Many of the mica crystals, especially near the walls, have cleavage planes normal to the contacts.

The granite and pegmatite at the Big Ridge mine are described on pp. 28-30. Here the mineralogic relations indicate that much of the pegmatite crystallized later than much of the granite, although the difference in age is not great. In some places the granite was probably the earliest material intruded along the irregular fractures, as it forms part of the wall rock of the pegmatite; in one place, at least, the granite was the last to form, for a dike 8 inches thick cuts sharply across both pegmatite and earlier granite.

At the Borrows Cut, a dike 5 feet thick has a core 2½ feet thick of quartzose fine-grained granite in which biotite flakes and streaks have parallel orientation. The pegmatitic border zones of this composite body are crowded with small mica books as much as 5 inches in diameter. The granite and pegmatite at the Tilley mine are described on p. 54.

OCCURRENCES OF MUSCOVITE

Muscovite occurs sporadically in most pegmatites, but where mineable, the blocks are large and clustered into certain rich "streaks" or "shoots". Table I summarizes the prevailing modes of occurence of mica in the 170 mines in the Franklin-Sylva district in which the localization of the mica could be either observed or inferred.

[10] Sterrett, D. B., op. cit., p. 202.

They include for the most part the best-exposed pegmatites and those that have the most clearly defined mica concentrations. Many other pegmatites are difficult to classify because of absence of mica or of pegmatite exposures. Difficulties arise in such a classification either because of the presence of more than one type of mica concentration in a single deposit, because the mica is not definitely concentrated, or because incomplete exposures in many places do not give a full picture of the pegmatite body. Observations are sufficiently numerous, however, to make the table of value in demonstrating the proportions of the various mica occurrences.

DISSEMINATED MICA

Mica blocks or clusters of blocks disseminated through a pegmatite body rather than in a well-defined streak or zone are not likely to be mined profitably for sheet mica. Some weathered bodies of this type, however, have been important sources of scrap mica. Scrap mica is abundant in the felpspathic pegmatite at the Iotla-Bradley mine (fig. 4), averaging about 10 percent of the rock and forming as much as 50 percent in places near quartz bodies. A little mica occurs in the quartz. This and similar pegmatites are classed with the disseminated deposits because of the presence of mica in such a large part of the pegmatite body, even though numerous scattered concentrations occur locally.

Scattered clusters of mica blocks occur sporadically in some small, irregular pegmatite bodies. Most mica at the Bettys Creek mine, for example, is found in thicker parts (as much as 6 feet thick) of the bodies, and bears no apparent relation to the small quartz bodies or to the walls. Other mica pegmatites in which the mica is disseminated or sporadic are the Putman, Gibson, Burr Knob, Oscar Queen, and Gurney Clay mines.

TABLE I

SUMMARY OF MICA LOCALIZATION IN PEGMATITES OF THE FRANKLIN-SYLVA DISTRICT

Type of mica occurrence	*Number of examples*	*Approximate percent*
Disseminated and sporadic distribution	9	5
Quartz core present:		
Mica near quartz core	68	40
Mica near walls	24	14
Mica near both quartz core and walls	29	17
Quartz core absent or inconspicuous:		
Mica near one wall	15	9
Mica near both walls	15	9
Mica near inclusions and walls	5	3
Mica possibly related to granite bodies within or in contact with pegmatite	5	3
Total	170	100

MICA RELATED TO QUARTZ CORES

The relation of mica shoots to quartz masses makes the margins of quartz bodies favorable for prospecting. As a general rule, rich mica shoots related to quartz cores tend to occur alongside the thickest parts of quartz masses. A thick quartz core, however, does not necessarily indicate a concentration of mica, for quartz bodies are much more numerous than rich mica streaks.

The disposition of the mica blocks with respect to the quartz bodies varies among the different deposits. In some the mica occurs throughout a thin zone between quartz and wall, but generally it is localized near either quartz or walls. In the majority of the quartz-core pegmatites, the mica blocks are clustered near the quartz. At the Raby mine, some mica crystals cross the contact between quartz and adjacent feldspathic pegmatite. Crystal faces are developed on the parts of the books projecting into the quartz, whereas the margins of the same books in feldspathic pegmatite (now kaolin) are ragged and irregular.

The mica blocks may be found more or less continuously along the margins of the quartz, but more commonly they are clustered in "shoots" or "pockets" separated by leaner feldspathic material. The long dimensions of some "shoots" can be correlated with the plunge of structural features such as flexures ("rolls") in the walls of the pegmatite body, which generally parallel the plunge of the pegmatite body as a whole. Mines

at which the mica blocks adhere closely to quartz cores are the Beasley No. 1, Lyle Cut, "A", Iotla-Bowers, Raby, Moody, Shepherd Knob, and Locust Tree. The size of the mica blocks generally diminishes away from the quartz mass.

Different from the above-described pegmatites are those in which the coarser mica blocks lie near the walls rather than near the central quartz body. Feldspathic zones with very little mica border the central quartz mass, and are composed of either coarse plagioclase or plagioclase with blocky microcline. Angular feldspar grains project into the massive quartz. At the Beasley No. 2 mine the coarsest mica blocks are separated from the hanging wall of the dike by a 6- to 12-inch border zone of medium-grained plagioclase, quartz, and mica (see discussion, p. 24); coarse oligoclase adjoins the massive quartz. Other examples of quartz-core pegmatites having mica near the walls are the May, Buoy No. 2, Painter, Bowers, Deets, Locust Ridge, and Gregory. The cleavage of the muscovite in some of these pegmatites shows a striking tendency to lie perpendicular to the walls, for example the Frady (p. 37) and Stillwell (p. 52) mines.

The occurrence of muscovite-rich zones along both quartz and walls is not uncommon. Examples are the Roda, W. G. Dillard, Doc Nichols, and Chalk Hill mines. At the Lin McCall mine, stained green wedge mica occurs near quartz masses, whereas clear and stained dark-rum mica occurs near the footwall. Muscovite has been mined near the quartz core in one pegmatite at the Baird mine; in another on the same property it occurs near the walls.

Muscovite generally occurs in plagioclase-rich pegmatite, in the Franklin-Sylva district as in other mica-producing pegmatite districts.[11] At the Farlow Gap mine, for example, coarse muscovite occurs near the walls in plagioclase pegmatite rather than in the quartz-microcline core. The central part of the Lyle Knob pegmatite body (pl. 12) is massive quartz, in places containing abundant microcline. Mica is concentrated near the walls of the pegmatite body where the percentage of plagioclase in the rock is higher.

Inasmuch as microcline tends to occur in the central parts of the zoned pegmatites of the Franklin-Sylva district rather than the margins, muscovite in a microcline-rich pegmatite would be most likely to occur nearer the walls. If microcline is scarce or absent, of course, mica may be found in plagioclase-rich zones near either walls or massive quartz cores.

Differences in mica content on the two sides of a quartz core are common. Mica at the Judge Ferguson mine was obtained mostly on the south side of a quartz mass four feet thick in a vertical pegmatite body 12 feet thick. Where the distribution is uneven, mica is generally more abundant on the upper side of the quartz. Differences in quality and color on the two sides of the quartz apparently exist also. For example, in the Long Branch and Gregory mines ruby mica occurs on the upper, whereas greenish-white specked mica occurs on the lower, side of the quartz bodies; in the Spence ruby mica on the upper side, and biotite near the footwall; in the Double Gap clear, rum mica on the upper side, and stained greenish-rum on the lower; and, in the Ramsey Buchanan clear mica on the upper side, and slightly stained on the lower. Two types of mica occur at a number of other mines in the Savannah section of Jackson County, including the Wilkes, Kolb, and Collins, but the positions of the two types within these pegmatites is not known. In all the above occurrences of two colors of muscovite, which are in the Savannah-Greens Creek-Cullowhee area of Jackson County, the poorer grade of mica is near the footwall.

MICA RELATED TO WALLS

Concentrations of mica are found in close proximity to walls and to inclusions of wall rocks at many mines. Zones near the walls commonly contain a higher proportion of plagioclase feldspar than the interior parts of the pegmatites. Where mica blocks occur in quantity along one wall but not the other, the hanging wall is generally favored. Mica streaks that occur both near walls and inclusions are found in the Caney Fork area of Jackson County. These pegmatites commonly contain tabular inclusions oriented parallel with the walls, and the pegmatite bodies, although irregular, generally conform to the foliation of their wall rocks. Examples of mines at which mica is localized near walls or inclusions are the Engle Cope (fig. 3), Lyle Knob (pl. 12), Shirley Wilson, Mack, Jeanie Deets, Aaron Hooper, Bud Williams, and Buzzard Roost.

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[11] See, for example:
Olson, J. C., Mica-bearing pegmatites of New Hampshire: U. S. Geol. Survey Bull. 931-P, 1941, p. 375.
Kesler, T. L., and Olson, J. C., Muscovite in the Spruce Pine district, N. C.: U. S. Geol. Survey Bull. 936-A, 1942, p. 10.
Cameron, E. N., Larrabee, D. M., et al., Structural and economic characteristics of New England mica deposits: U. S. Geol. Survey press bulletin, September 1944.

MICA ASSOCIATED WITH GRANITE BODIES

Granite bodies, discussed on page 10, are closely related to the mica-bearing pegmatites in at least five composite dikes. The granite bodies at the Big Ridge and Tilley mines are described on pages 28 and 54. The granite "cores" at the Moss, Borrows Cut, and Roarenhole mines occupy central positions within pegmatite masses, like the quartz cores of other pegmatites. Mica occurs in thin layers of coarse-grained pegmatite along the margins of the granite. It is uncertain at present whether the concentration of the muscovite in the coarse-grained pegmatite was due to some effect of the granite, or whether the close spatial relation betwen muscovite and granite is only coincidental.

SOURCE AND EMPLACEMENT OF PEGMATITE

The source of the pegmatite may best be considered by drawing a comparison with the Spruce Pine pegmatite district 100 miles to the northeast. The Franklin-Sylva district corresponds to the northwest half of the Spruce Pine district, inasmuch as it contains very little granite and the muscovite is dominantly rum or ruby in color and generally clear. The Cashiers district corresponds to the southeast half of the Spruce Pine district, which is characterized by much granite as well as muscovite that is characteristically green or brown and not uncommonly stained. The change in color of muscovite in different parts of the districts is very broad and general, and local exceptions are numerous.

The granitic bodies in the Spruce Pine and Cashiers districts are coarse and pegmatitic, and are surrounded by shells of gneiss thoroughly permeated by granitic material. The granite of the Cashiers district probably contains more biotite and potash feldspar on the average than that at Spruce Pine. The main Franklin-Sylva pegmatite belt is separated from the granite masses of the Cashiers district by a relatively barren zone 5 to 10 miles wide in which there are very few mica-bearing pegmatites. (See pl. 1.) Similar, although much smaller, barren areas occur near the middle of the Spruce Pine district. The pegmatites at Spruce Pine are believed to have been derived from granitic rock whose present exposures lie mostly in the southeast part of the pegmatite district.[12] Similarly, the probable source of the Franklin-Sylva pegmatites is a granitic rock at depth, related to or part of the Whiteside granite masses of late Paleozoic age now exposed to the southeast in the Cashiers district (pl. 1). Apparently at the time of this granitic intrusion the pegmatites were emplaced in fractures and zones of weakness in the already folded and metamorphosed gneiss and schist.

The minerals in the pegmatites that have formed in fractures appear to have been deposited essentially from the walls inward. This mode of formation is indicated by the fine-grained border zones, the cores of massive quartz that in many places have angular contacts with adjacent feldspar crystals, and the variation in content of microcline, plagioclase, and muscovite with relation to the walls, as described in preceding paragraphs. Most of the pegmatites are composed of relatively few minerals. Modification of the original pegmatite by later processes, such as albitization or large-scale replacement, is inconspicuous.

The cores of the composite dikes, described on p. 10, are granite rather than quartz or another type of pegmatite. The granite at the Big Ridge mine occurs as the core, as part of the wall rock, and as dikes cutting both pegmatite and wall rock. The crystallization periods of granite and pegmatite here overlapped. The granite cores of the other composite dikes, like the quartz cores, probably solidified after the pegmatite along the walls, although the difference in age is probably slight.

MUSCOVITE

PROPERTIES

Muscovite is indispensable as an insulating material in certain types of electrical and radio equipment because of its unique combination of physical properties and our inability thus far to find a satisfactory substitute for certain uses. The most important physical properties in determining the value of sheet mica are cleavage, flexibility, staining, color, intergrowths with other minerals, and certain electrical properties. To be suitable for the most exacting uses, the mica must split readily into flat, clear, firm, flexible sheets, without staining, air or water bubbles, pinholes, or other inperfections.

[12] Olson, J. C., Economic geology of the Spruce Pine pegmatite district, North Carolina: North Carolina Dept. Cons. and Devel. Bull. 43, 1944.

Muscovite crystallizes in the monoclinic system, and perfect crystals have nearly hexagonal outlines. Well-formed crystals are particularly common at the Tilley mine and occur sparsely in other pegmatites in the district, but by far the greater part of the commercial mica occurs as rough blocky masses of irregular shape. The largest mica block, or "book", reported from the Franklin-Sylva district was found in 1907 at the Iotla-Bradley (Iotla Bridge) mine. It weighed more than 4,000 pounds, and measured 4 feet in length or thickness[13] and 29 by 36 inches in cross-section.

Certain physical peculiarities of "book" muscovite are of great economic importance. *"A" mica* is less valuable than flat, for the surfaces of the sheets are marred by chevron-like "reeves" or lines that intersect at an angle near 60 degrees, forming a "V". Some of the "A" structures are due to the tapering out of certain sheets along straight lines; others are due to closely-spaced folds or corrugations, called *"ridges"* or *"reeves"*, and mica possessing this feature is said to be *"reeved"*. "A" mica occurs in variable proportions in most of the mines in the district, but is of minor quantitative importance at most mines. "A" mica from which flat mica can be obtained by trimming between the reeves is known as *"flat A"* mica. Mica crystals, mostly of "A" type, that taper in thickness are known as *"wedge"* mica. *"Herringbone"* mica differs from "A" mica in having two sets of reeves that intersect a central spine-like set at angles of about 60 degrees. Mica that tears when split, generally because of the intergrowth of adjacent sheets, is said to be *"tanglesheet"*, *"tied"*, *"gummy"*, or *"locked"*. Random fine cracks are known as *"haircracks"*. *"Ruled"* mica is mica that is broken along sharply defined parting planes that intersect at angles near 60° and lie at an angle of nearly 67° with the cleavage plane. Ruling that is strongly developed in only one direction yields strips of *"ribbon"* mica. Ruling in two or three directions yields sheets of rhombic or triangular shape. Ruled mica results from distortion of the crystal by rock movements and is conspicuous near faults. The most productive sheet mica mines are therefore in pegmatites that have not been deformed.

Intergrowths with other minerals impair the mica. The most common is that of muscovite with biotite, an intergrowth in which the cleavages of the two minerals are parallel. Although the presence of intergrown biotite lowers the value of an individual muscovite book, the presence of biotite in a muscovite-bearing rock generally indicates that the muscovite is ruby or rum in color rather than green or stained. Other minerals intergrown with muscovite are quartz, plagioclase, flat and euhedral garnet, tourmaline, apatite, and allanite.

The color of muscovite is denoted by the terms ruby (red or pink), rum (light-brown), green, white, and dark-rum or brown. Staining of primary origin in mica is due to inclusions of hematite, magnetite, or tiny flakes of biotite. The type of staining due to small biotite flakes is rare but occurs in the Caney Fork area of Jackson County. The most common secondary stains are caused by the infiltration of fine clay particles between the laminae and are called clay stains. Limonite commonly occurs as a result of the alteration of magnetite and hematite inclusions. Air and water bubbles occur between some sheets. If few, they can be removed by careful splitting, but if abundant they lower the value of the mica.

The most important electrical property of mica is the power factor. Power factor, expressed in percent, is a measure of the loss of electrical energy in a condenser in which the mica forms the dielectric medium. Mica having a power factor greater than 0.04 percent is seldom used in condensers. The power factor of muscovite is greatly increased by the presence of such imperfections as staining, haircracks, pinholes, and air bubbles.

CLASSIFICATION AND GRADING

As the mica is taken from the mine, all that is obviously scrap because of physical defects or small size is segregated as "mine scrap" mica. The remaining mine-run mica is then split and trimmed ("rifted") in the mica shop. The products of the rifting process are sheet, punch or circle, and shop scrap. The common sizes into which sheet and punch mica are graded, and the approximate percentages of each size that have been produced from 12 outstanding mines during the period 1922-42, are shown in table III (page 18) which includes only mica classed as clear. Punch mica ordinarily includes clear sheet mica smaller than 1¼ by 2 inches but larger than a circle 1¼ inches in diameter, and stained sheet mica smaller than 2 by 2 but larger than a circle 1½ inches in diameter. The circle classification, as employed in the Franklin-Sylva district, ordinarily includes sheets ranging from a circle 2 inches in diameter to a 2 by 3 inch rectangle. During

[13] Sterrett, D. B., op. cit., p. 235.

the war, in accordance with increased demands for small mica, the minimum acceptable size for punch mica was lowered to 1 by 1 inch, and prices were based upon full and three-quarter trim, a higher standard of preparation than existed in pre-war years.

Sheet mica is classified qualitatively into two primary divisions: "clear" and "stained". It may also be classified as No. 1, No. 2, or No. 3. No. 1 is clear mica of good quality, corresponding approximately to the Indian and A. S. T. M. grades of "clear", "clear and slightly stained", "fair-stained", and some "good-stained". No. 2 is less perfect because of curved cleavage, clay-staining, minor iron-oxide staining, or air bubbles; it corresponds to the Indian "stained" classification and possibly to some Indian "black-stained". No. 3 mica is heavily stained, like the Indian "black-stained or spotted" mica. The No. 2 mica has been further divided into "No. 2 regular" and "No. 2 inferior". In general the sizes and qualities in greatest demand during the war, and for which a premium price has been paid by the Colonial Mica Corporation, include full-trimmed punch mica larger than 1 by 1 inch and full and three-quarter trimmed sheet mica 1½ by 2 inches or larger, of No. 1 and No. 2 qualities. Prices, classification, and methods of preparation have varied during the war as well as in pre-war years, and the reader is referred to other publications[14] for further discussions of the mica industry.

QUALITATIVE DISTRIBUTION OF MUSCOVITE

The muscovite throughout the Franklin-Sylva district has a strikingly uniform rum to ruby color. On the average, mica from the northwest half of the belt has a slightly redder hue than that from the southeast. Mica from the parallel Cashiers district, 10 to 15 miles to the southeast, has a predominant dark-rum or greenish hue, and much of it is specked or stained. This type of mica is also common in the southeastern part of the Franklin-Sylva district, in the Wolf Mountain-Pinhook Gap area. Black-stained mica is relatively uncommon in the district, but staining caused by many minute biotite flakes in the mica is particularly common in the Caney Fork area of Jackson County.

The quality of some of the mica in the Franklin-Sylva district is lowered by imperfections such as waviness, mottling and surface stains, haircracks, tangle-sheet structure, and ruling. Ruling and waviness are related to the faults of small displacement that are widespread throughout the district. "A" structure is common in the Cashiers district. In the Franklin-Sylva district it is found at many localities but impairs far less mica than in some other domestic mica districts. Wedge "A" mica is abundant in several pegmatites near Greens Creek, Jackson County.

No clearcut relation has been established between quality of mica and type of mica occurrence or shape of the enclosing pegmatite body. In general, the irregular pegmatite bodies that contain many tabular inclusions of wall rock and only small or scattered quartz masses yield a lower percentage of high-quality sheet mica than the more sharply defined, discordant dikes that have well-developed quartz cores. Pegmatites mined predominantly for scrap mica are represented among the large irregular masses—for example the Iotla-Bradley, Berry, Burr Knob, Big Flint, Annie Laurie, and in large part the Shepherd Knob. Likewise, pegmatite bodies with similar structures in the Caney Fork area have yielded dark-colored mica that is commonly stained.

MINING

HISTORY

Pegmatite mining in the district began with the production of kaolin by the Cherokee Indians, presumably for shipment to England. As early as 1744, an English patent was recorded for the production of porcelain from an earthy mixture produced by the Cherokee Nation in America, consisting probably of kaolin,

[14] See, for example:
Wierum, H. F., and others, The mica industry: U. S. Tariff Commission, Rept. 130, 2nd ser., 1938.
A. S. T. M., Grading and classification of natural mica: Amer. Soc. for Testing Mater., Release D-351-38, 1938.
War Production Board mica releases No. 1 and No. 2, July 6, 1942.
Gwinn, G. R., Strategic mica: U. S. Bur. Mines Inf. Circ. 7258, 1943.
Wayland, R. G., Mica in war: Mining Technology, vol. 8, no. 4, July, 1944.
Billings, M. H., and Montague, S. A., The wartime problem of mica supply; Eng. and Min. Jour., vol. 145, no. 8, pp. 92-95, 1944.
Lintner, E. J., Mica, a war essential mineral: Rock Products, vol. 47, no. 5, pp. 48-50, 92-93; no. 6, pp. 74-76, 114-116, 1944.

feldspar, and quartz.[15] Thomas Griffiths came to the Cowee section of Macon County from England to obtain kaolin in 1767.[16] He cleaned out an old pit from which kaolin had been extracted previously, and transported at least 5 tons of the kaolin to Charleston for shipment to England. Modern kaolin mining in North Carolina began about 1888 near Webster, in Jackson County. For a number of years the production was largely from the Franklin-Sylva district, and was small, but about 1900 North Carolina began to gain prominence as a kaolin-producing state. In recent years, North Carolina's entire output has been from the larger deposits in the Spruce Pine district.

Mica is believed to have been mined by the early Indians presumably for ornamental purposes. Remains of extensive workings of ancient origin are reported to have been found at the Baird mine.[17] Sterrett[18] summarizes the beginnings of mica mining as follows: "Modern mica mining in North Carolina was begun in 1867 by L. E. Persons, of Philadelphia, previously of Vermont. Mr. Persons' attention was directed to Jackson County by someone in Philadelphia who had seen a mica crystal exhibited at the State fair in Columbia, S. C., in 1858, by D. D. Davies, of Webster. In the autumn of 1867, Mr. Persons went to Jackson County and learned from Mr. Davies the location of favorable prospects for mica in Jackson and Haywood Counties, which he soon opened." The Big Ridge mine is generally considered to be the first mica mine to be developed in the district.

METHODS

The weathered near-surface parts of pegmatites are mined first by pick-and-shovel open-cut methods, although in some places steam shovels, drag lines, bulldozers, and hydraulic methods have been used in soft material. Timbering is ordinarily necessary as soon as underground work is begun, as workings cave easily. The deeper mines encounter hard rock that must be drilled and blasted. Barren rock is not broken unless absolutely necessary; hence, many openings are narrow and tortuous.

The pegmatite mining is for mica almost exclusively, although many mines were first developed for kaolin, and the principal product at the Sally Reed, Lin McCall, McGuire, and Doc Sanders mines has been feldspar. As a general rule, only one pegmatite body is mined at any one mine. The largest workings for sheet mica are those at the Big Ridge mine, described on page 28. Some mines have been very productive although the sizes of their openings are small—for example, the Moody, described on page 42, and the Beasley No. 1, described on pages 20-22. Doubtless unusually rich mica shoots were mined from these two mines.

ECONOMIC FACTORS

In the average sheet-mica mining operation, from 5 to 15 tons of rock are moved daily, yielding a few to 500 pounds of mine-run mica. The largest sheet-mica operation in 1942, the Big Ridge mine, yielded about 2,300 pounds of mine-run mica daily, while 29 tons of waste rock were moved to the dump during a 14-man 10-hour shift. Inasmuch as some muck or waste was also left in the mine on lofts, the mine-run mica evidently constituted between 3 and 4 percent of the total pegmatite mined. Additional figures on more recent output of the Big Ridge mine are given on page 32.

Total mica in the rock mined probably ranges from 3 to 10 percent at most good mica mines, but if mine scrap and mica too small to be recovered are excluded, the mine-run mica probably ranges from about one to four percent of the rock mined. The decomposed pegmatites at the Iotla-Bradley and Shepherd Knob mines are estimated to be 10 to 12 percent muscovite, but their content of scrap mica is exceptionally large. The output of a typical sheet-mica mine, under pre-war conditions which permitted the inclusions of much low-grade material in the sheet and punch mica, consisted of about 80 percent scrap, 15 to 16 percent punch, and 4 to 5 percent sheet mica. Different standards of quality and preparation during the war have brought about a diminution in the percentages of sheet and punch mica recovered. Table III shows the proportions of punch, circle, and various sizes of sheet in nearly 2,000,000 pounds of mica produced from 12 mica mines in the Franklin-Sylva district during the period 1922-42, and similar figures for the Big Ridge mine. These indicate what sizes might be expected in the future from the better mines in the district. Scrap mica generally averages 65 to 95 percent of the total mica produced.

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[15] Watts, A. S., Mining and treatment of feldspar and kaolin in the Southern Appalachian region: U. S. Bur. Mines Bull. 53, p. 10, 1913.
[16] Ceramic Age, vol. 14, no. 5, pp. 165-169, November 1929.
[17] Smith, C. D., Ancient mica mine in North Carolina: Smithsonian Inst. Rept., pp. 441-443, 1876.
[18] Sterrett, D. B., op. cit., p. 167.

The proportion of high-quality sheet and punch mica to the total mine run has become increasingly important as a factor in mining, because of the increased demand for such qualities during the war. The mica is classified quantitatively according to percentages of No. 1, No. 2, "No. 2 inferior", and No. 3 grades. The proportion of Nos. 1, 2, and "2 inferior" to the total mine run averages only a few percent, rarely exceeding 12 percent, but upon this ratio depends to a great extent the value of the total mine-run mica.

SCRAP MICA

Scrap mica is obtained in the Franklin-Sylva district both as a by-product from sheet-mica mining and from decomposed pegmatite mined chiefly for scrap mica by pick-and-shovel, power shovel, or drag-line methods. In 1942, three plants for recovery of scrap mica were in operation near Franklin, utilizing material from large open cuts in weathered pegmatite and from dumps of previous sheet mica mining operations. In 1944 scrap mica was being produced by the following concerns:

(1) Bradley Mining Company, and (2) Duvall and Liner, both at Iotla Bridge on the Little Tennessee River.

(3) Fred Arnold (Arnold Mines) plant about one mile southeast of Iotla Bridge, on the Little Tennessee River.

(4) The Franklin Mineral Products Company mica grinding plant in Franklin.

The feed for the several scrap mica washing plants is either decomposed pegmatite or dump material from old mica mines. The decomposed pegmatite used in the summer of 1944 was mined from the Iotla-Bradley and Shepherd Knob pegmatites, and is reported to have averaged about 10 percent muscovite. The large pegmatites rich in small mica have been best suited to this purpose—for example the Shepherd Knob (pl. 17), Iotla-Bradley (p. 37), Berry, and Big Flint (p. 26).

FELDSPAR

In the Franklin-Sylva pegmatites feldspar is at present the only mineral of commercial value other than mica. The relatively low price of crude feldspar does not permit profitable production where mining or transportation costs are high; accessibility and haulage facilities are more significant economic factors than in mica mining. Feldspar mining has seldom been profitable in the Franklin-Sylva district because of the low unit value (about $6 to $7.50 per ton) and the high cost of transportation to the nearest market at Spruce Pine, about 100 miles distant. Pegmatites suitable for feldspar mining are more sparsely distributed in the Franklin-Sylva district than at Spruce Pine, but coarse potash feldspar is abundant in some pegmatites, particularly several in the Pinhook Gap-Wolf Mountain area of Jackson County.

Feldspar has been produced since about 1933 near Bryson City, in Swain County, adjoining the Franklin-Sylva district on the northwest. Prior to the summer of 1945 this feldspar had been shipped to Spruce Pine either by rail or truck. In the fall of 1945 a feldspar grinding mill was put into operation at Dillsboro and plans were under way for the construction of another at Bryson City.

PAST PRODUCTION

Reliable and complete production figures for the Franklin-Sylva district are not available for years prior to 1942. Minerals Yearbook[19] lists the annual production of combined sheet and punch mica for the State of North Carolina, shown in Table II for the period 1920-44. Purchase records of the Asheville Mica Company, buyers of nearly all of the mica in the district, were also consulted and provided the most accurate basis for estimating the amount of mica produced by the district during the period 1922-42. During this period, sales of mica were made from more than 75 mines; a summary of the approximate total production of 12 of the mines for which the records are most complete is shown in Table III.

The 12 mines whose production is shown in Table III produced most but by no means all of the mica from the district during the years 1922-42, for at least 75 mines were active at times during this period. The total for the 12 mines, 1,998,266 pounds of sheet and punch mica, can be compared with the State's total for a similar 21-year period 1920-40, for which production figures are available. During the period 1920-40 North Carolina's output amounted to 13,263,462 pounds of sheet and punch mica, valued at $2,557,511 (table II). From these figures it is estimated that the annual production of sheet and punch mica in the Franklin-Sylva district during the period 1920-40 was nearly 20 percent of the total for the State, or nearly 126,000 pounds of sheet and punch mica annually. Most of the remainder of North Carolina's output, probably about 75 percent of the total, has been obtained from the Spruce Pine district.

[19] U. S. Bur. Mines, Minerals Yearbook.

TABLE II

RECORDED PRODUCTION[20] OF SHEET AND PUNCH MICA FROM NORTH CAROLINA, 1920-44

Year	*Amount (Pounds)*	*Value*
1920	1,084,946	$405,654
1921	230,532	51,851
1922	544,495	119,767
1923	1,130,283	188,317
1924	597,385	108,656
1925	592,478	105,376
1926	700,313	150,362
1927	665,360	114,514
1928	777,395	129,706
1929	894,200	150,293
1930	749,074	112,451
1931	389,426	51,657
1932	127,696	18,322
1933	162,672	21,107
1934	293,381	38,674
1935	512,590	77,598
1936	730,446	119,653
1937	1,044,328	218,176
1938	632,646	87,879
1939	401,170	69,344
1940	1,002,646	218,154
1941	1,614,863	318,783
1942	1,654,895	505,634
1943	1,901,120	1,772,324
1944	814,874	1,530,625

[20] U. S. Bur. Mines, Minerals Yearbook.

TABLE III

APPROXIMATE PRODUCTION OF SHEET AND PUNCH MICA FROM THE BIG RIDGE AND 11 OTHER MINES IN THE FRANKLIN-SYLVA DISTRICT, 1922-42

Size of sheet (inches)	Big Ridge mine[21]		12 of the principal producers including Big Ridge	
	Pounds	Percent of total sheet	Pounds	Percent of total sheet
8 x 10	74	0.02	83	0.02
6 x 8	852	0.21	1,016	0.20
4 x 6	11,228	2.79	12,747	2.54
3 x 5	24,409	6.01	27,865	5.56
3 x 4	19,532	4.73	23,278	4.65
3 x 3	35,361	8.33	41,664	8.32
2 x 3	99,479	23.24	117,402	23.45
2 x 2	83,894	19.92	102,816	20.53
1½ x 2	146,338	34.75	173,780	34.73
Unclassified sheet			10,000	
		Percent of total sheet, circle, and punch		Percent of total sheet, circle, and punch
Total sheet	421,167	35.55	510,651	25.56
Total punch	763,505	64.45	1,372,497	68.69
Total circle			115,118	5.75
Total sheet, circle, and punch	1,184,672	100.00	1,998,266	100.00

[21] Published by permission of K. A. Sprague, Haywood Lumber and Mining Company.

Production of high-quality mica under conditions of heavy demand and intensive mining activity during the war years, 1943-1944, is shown in Table IV. The amounts shown for 1942-44 cannot be compared directly with the figures for previous years because of the differences in quality of preparation and grading. The pre-1942 data apply to half-trimmed sheet mica (1½ by 2 inches and larger), both clear and stained, and untrimmed punch (1¼ inches in diameter). The mica sold to Colonial Mica Corporation since 1942 has been three-quarter trimmed and full-trimmed sheet (1½ by 2 inches and larger) and full-trimmed punch (1 by 1 inches and larger) of No. 1 and No. 2 qualities, which exclude much heavily-stained mica.

FUTURE POSSIBILITIES

The history of past production of the district is the most reliable basis from which to estimate possibilities of future production. The average annual production during the years 1920-40 is estimated to be nearly 126,000 pounds of sheet and punch mica of all qualities. The monthly average of 10,500 pounds of high-quality sheet and punch mica during the last half of 1944 (see table IV) indicates the potentialities of the district under intensive development. This rate of production could probably be maintained for at least several years by the continued operation of productive mines and the development of other prospects as the more productive mines become depleted. An increase would probably result from the development of additional headings at some of the better mines.

TABLE IV

PRODUCTION OF MICA OF QUALITIES ACCEPTABLE BY COLONIAL MICA CORPORATION IN THE FRANKLIN-SYLVA DISTRICT, 1943-44[22]

Period	*Pounds Sheet*
Oct.-Dec. 1943	24,578.49
Jan.-June 1944	51,599.79
July-Dec. 1944	63,004.62
Total Oct. 1943-Dec. 1944	139,182.90

[22] Published by permission of Colonial Mica Corporation.

DESCRIPTIONS OF SELECTED MINES

ALLMAN COVE MICA MINES

J. M. PARKER III

The Allman Cove group of mines is 1¼ miles northwest of the center of the town of Franklin, in the east-central part of the Franklin quadrangle. The mines lie on low ridges west of North Carolina Highway 28, from which they are easily reached over half a mile of good dirt road. The group includes the Allman Cove mine, the Mudhole mine, and the Willis mine.

The earliest work at the Allman Cove mine was done about 1870 or 1880. Surface mining was done and a long adit was driven northward from the creek. (See pl. 3.) About 1904, the large pit at the west end of the workings was worked for kaolin to a depth of about 60 feet. The mine has been worked intermittently by many operators. Mica suitable for condensers and telephone equipment is reported to have been produced in 1918 or 1919. Since 1925 operations have been nearly continuous and have been carried on mainly by John and W. P. Brindle, John and Floyd Tallent, and J. W. Roper. The mine was worked between January and March 1943 by F. E. Snow and E. B. Ward, and then until the summer of 1943 by Mr. Snow.

The Mudhole mine was first explored about 1930 by John Tallent. The last operation, by Tallent and Roper, was abandoned in 1942 when the shaft became dangerous and the volume of water became difficult to handle.

The Willis mine was worked first by Fred Willis, about 1926, and more recently by John Tallent and Ivy Crisp, the present owner. In July 1943, F. E. Snow drove a tunnel westward along the dike below the earlier workings.

The Allman Cove mine consists of three large and several small pits, at least 16 shafts ranging in depth from about 15 to 90 feet, and many short drifts at various levels. The underground workings are now inaccessible, except the deep shaft and stopes at the east end. It is judged from reports that the pegmatite may have been almost completely worked out down to water level, which is 50 to 70 feet below the surface, a little above the altitude of the creek to the south.

The pegmatite body is nearly divided into two parts by a projection of wall rock (mica gneiss) near the middle of the workings. The pegmatite body thickens both east and west of this point. The eastern part trends east and is nearly vertical. In the easternmost shaft the pegmatite is only 18 inches thick, but it is nearly 30 feet thick in the main workings, and about 20 feet thick in the large pit. The west part of the pegmatite trends N.70°W. and probably dips steeply to the south. It is about 20 feet thick and probably tapers out at the southeast end and branches into several stringers at the northwest end. The pegmatite is intrusive into mica gneiss; in general it lies parallel to the strike of the foliation but in places cuts across it.

The pegmatite is composed of partly kaolinized feldspar (probably plagioclase), quartz, muscovite, and biotite. The eastern part of the pegmatite contains a number of irregular streaks of "burr rock", which has been described on page 9. All of the mica seen in the east workings was small, wavy, ruled, and cracked. Most of it was scrap but a little would yield punch or sheet up to about 2 by 2 inches. The mica was moderately stained by clay and iron oxide, and intergrowths with biotite were abundant.

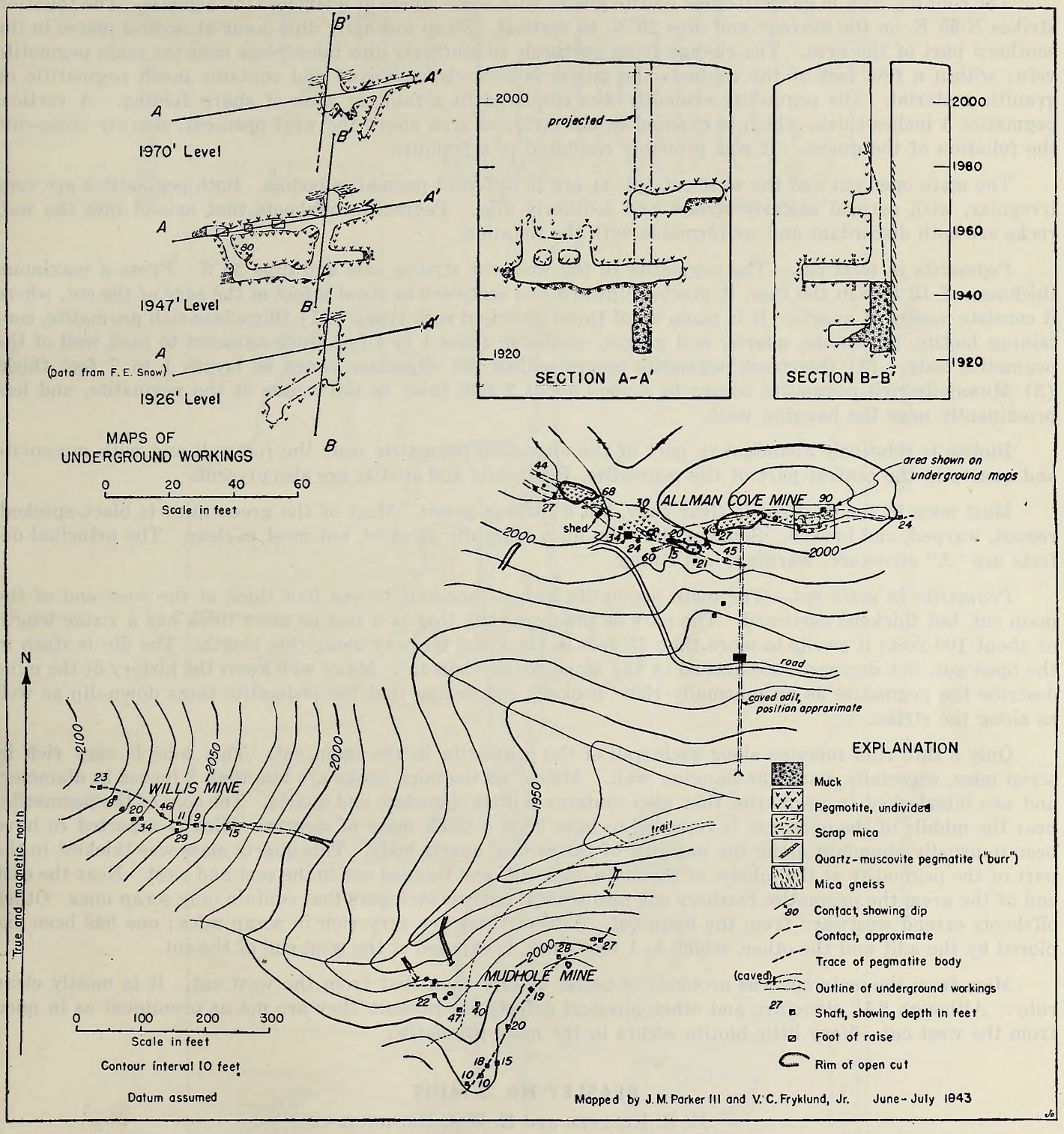
The underground workings at the west end were flooded and could not be examined; hence the following description of this part of the pegmatite is based upon reports by miners. A well-defined quartz mass, 2 to at least 3 feet thick, in part "burr rock", lies in the middle of the pegmatite body. Sheet mica has been found on both sides of it, but most of the mica is along the south wall. The mica occurs in larger books at this end than at the east, but it is considerably ruled. Flat, hard, clear, dark-rum mica is produced. Very little biotite is found.

BEASLEY No. 1 MINE

M. R. KLEPPER and J. C. OLSON

The first work at the Beasley No. 1 mine is reported to have been done in the main open cut about 1880 or 1885. A large amount of mica is said to have been mined from an unusually rich pegmatite vein during a period of several years. The old dumps were later reworked for scrap mica. After many years of idleness,

BULLETIN 49 PLATE 3



MAP AND SECTIONS OF THE ALLMAN COVE MINE, MACON COUNTY.

the mine was leased in June 1943, to the Thurman Mining Company, which developed all of the west open-cut. This operation was abandoned about the end of April 1944.

The country rock is garnetiferous biotite gneiss with some layers of quartzose mica gneiss. The foliation strikes N.65°E. on the average and dips 25°N. to vertical. Steep southerly dips occur at several places in the southern part of the area. The change from northerly to southerly dips takes place near the main pegmatite vein; within a few feet of the contacts the gneiss is severely contorted and contains much pegmatitic or granitic material. The pegmatite evidently was emplaced in a fault or zone of sharp folding. A vertical pegmatite 3 inches thick, which is exposed in the stripped area above the west open-cut, sharply cross-cuts the foliation of the gneiss. It was probably emplaced in a fracture.

The main open cut and the west cut (pl. 4) are in different pegmatite bodies. Both pegmatites are very irregular, with general easterly strikes and southerly dips. Pegmatite offshoots that extend into the wall rocks are both discordant and conformable with the foliation.

Pegmatite in west cut.—The pegmatite in the west cut strikes east and dips 55°S. From a maximum thickness of 12 feet in the face, it pinches upward and eastward to about a foot at the edge of the cut, where it consists mostly of quartz. It is made up of three principal rock types. (1) Oligoclase-rich pegmatite, containing biotite, muscovite, quartz, and garnet, occurs in zones 1 to 4 feet thick adjacent to each wall of the pegmatite body. (2) Quartzose pegmatite occurs within the oligoclase zones as layers 1 to 7 feet thick. (3) Muscovite-rich pegmatite occurs in a zone about 2 feet thick in the center of the pegmatite, and less prominently near the hanging wall.

Biotite is relatively abundant in part of the oligoclase pegmatite near the footwall and with muscovite and quartz in the central part of the pegmatite. Pyrrhotite and apatite are also present.

Most mica in the west cut is clear ruby, but a little is green. Most of the green mica is black-specked, reeved, warped, and broken. Some of the ruby mica is lightly specked, but most is clear. The principal defects are "A" structure, warping, and ruling.

Pegmatite in main cut.—The main pegmatite body is one-half to one foot thick at the west end of the main cut, but thickens eastward. The part of the pegmatite that is 5 feet or more thick has a strike length of about 100 feet; it swells to more than 15 feet in thickness midway along this length. The dip is steep in the open cut, but decreases southward in the stope to less than 45°. Many who know the history of the mine describe the pegmatite as an unusually rich "pocket", suggesting that the pegmatite thins down-dip as well as along the strike.

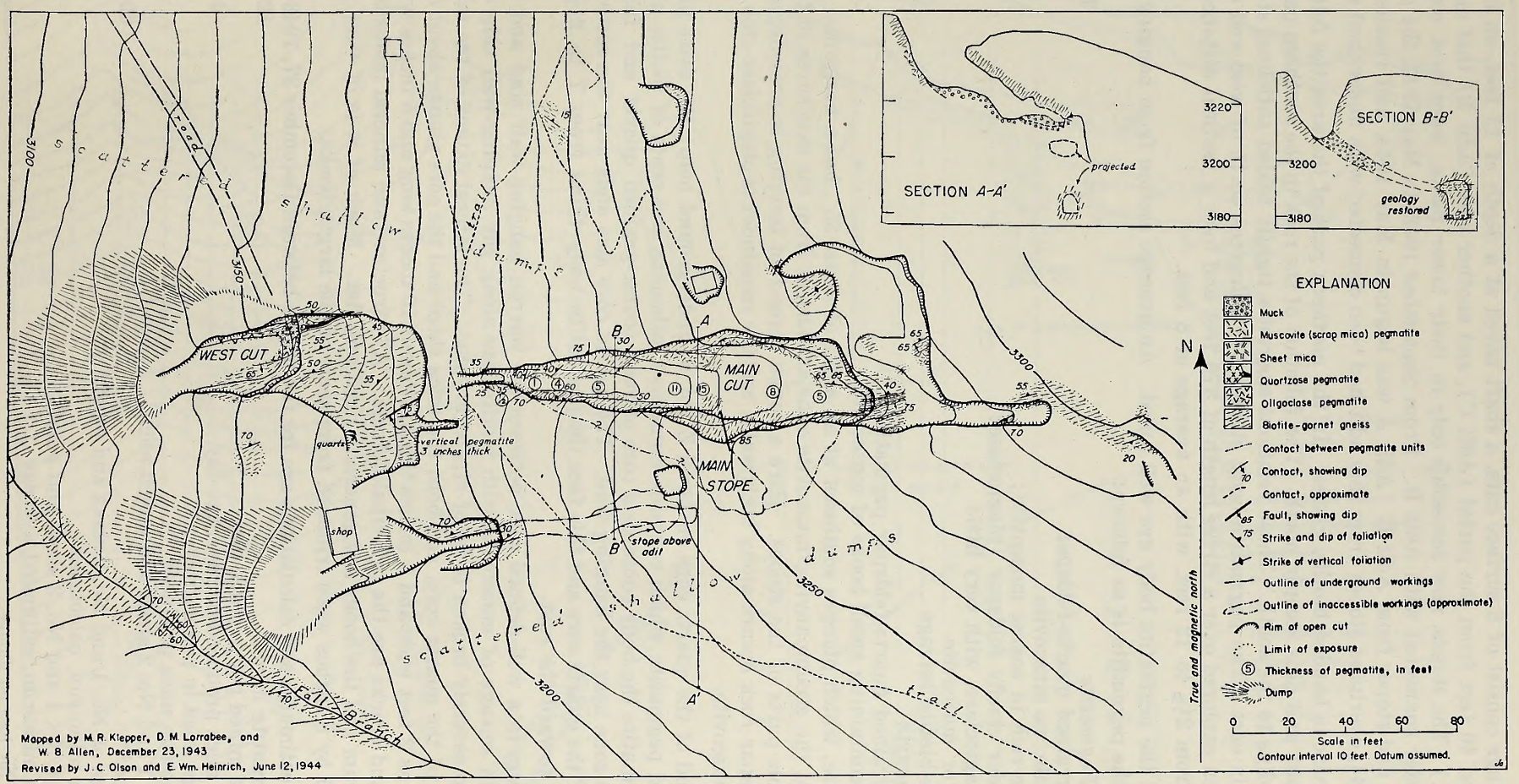
Only a thin rind remains along each wall of the pegmatite in the main cut. This zone is very rich in scrap mica, especially along the hanging wall. Almost all the mica books are less than 2 inches in diameter, and are interlocked in pegmatite that also contains a little oligoclase and quartz. The core of the pegmatite, near the middle of the open cut, is reported to have been a thick mass of quartz. Mica is reported to have been unusually abundant along the margins of the central quartz body. This quartz mass was thickest in the part of the pegmatite at the middle of the main open cut, and thinned out to the east and west. Near the east end of the area, the pegmatite feathers out into several narrow stringers that contain only scrap mica. Other offshoots extend westward from the main cut. Two of these are very rich in scrap mica; one has been explored by the adit and the other, which is 1 foot thick, is exposed at the west end of the cut.

Mica from the main cut was probably of better quality than that from the west cut. It is mostly clear ruby. Although "A" structure and other physical defects are present, they are not as prominent as in mica from the west cut. Very little biotite occurs in the main pegmatite.

BEASLEY No. 2 MINE

M. R. KLEPPER and E. WM. HEINRICH

The Beasley No. 2 mine is 8 airline miles N.25°E. of Franklin. It lies near the head of an unnamed branch on the north side of Caler Fork Valley, at an altitude of 3,150 feet. The mine is reported to have been operated by the Bowers brothers of Franklin in 1890, and has been worked intermittently up to the present time. It is owned by the Masonic Lodge of Franklin, who leased it in the summer of 1942 to the Asheville Mica Company of Biltmore, N. C. Operations were begun on September 1, 1942.



MAP AND SECTIONS OF THE BEASLEY NO. 1 MINE, MACON COUNTY.

The old workings consist of 8 surface cuts, a shaft caved at a depth of 13 feet, an inaccessible inclined shaft, an adit caved 40 feet from the portal (Adit C), and another adit (Adit B) that opens into drifts and stopes. (See pl. 5.) The stopes, now accessible only in their lower parts, were first worked from the inclined shaft and later connected with Adit B. From September 1942, to May 1943, the pegmatite body was mined in the drift and stopes from Adit B. Adit A was begun in May 1943, and reached the pegmatite in June. By May 1944, overhand stopes from this adit had been connected with underhand stopes from Adit B.

The country rock is banded biotite gneiss. In the northern part of the area the foliation strikes a few degrees north of east and dips steeply north. The foliation of the rock in the southern part of the area has a similar strike but dips to the south. These relations suggest a tightly folded anticlinal structure, the axis of which trends nearly east. The pegmatite body strikes a few degrees north of west and dips on the average 45°SW. It has been explored over a strike length of 370 feet and over a vertical distance of 250 feet. The thickness ranges from 2½ to 12 feet, with an average of 8 feet.

Some parts of the pegmatite body are well zoned. An average section from hanging wall to footwall in the zoned part of the pegmatite is as follows:

Pegmatite	*Thickness*
Medium-grained quartz-feldspar pegmatite; no muscovite	6″ to 1′
Pegmatite rich in coarse muscovite; remainder chiefly feldspar (plagioclase?)	1′ to 1½′
Coarse plagioclase, with very little quartz or muscovite	2′ to 2½′
Muscovite-biotite selvage	3″ to 6″
Massive quartz	3′ to 4′
Medium-grained quartz-feldspar pegmatite locally containing small books of muscovite	6″ to 1′

The quartz core, which plunges southeast at an angle of about 35°, has a horizontal width of about 120 feet. The core and the accompanying muscovite zone are absent from the exposures in the surface cuts and the higher accessible parts of the stopes. Here a rough three-fold layering is present; a narrow selvage of barren quartz-feldspar rock occurs along both walls, and the remainder is plagioclase-rich pegmatite that contains biotite and muscovite.

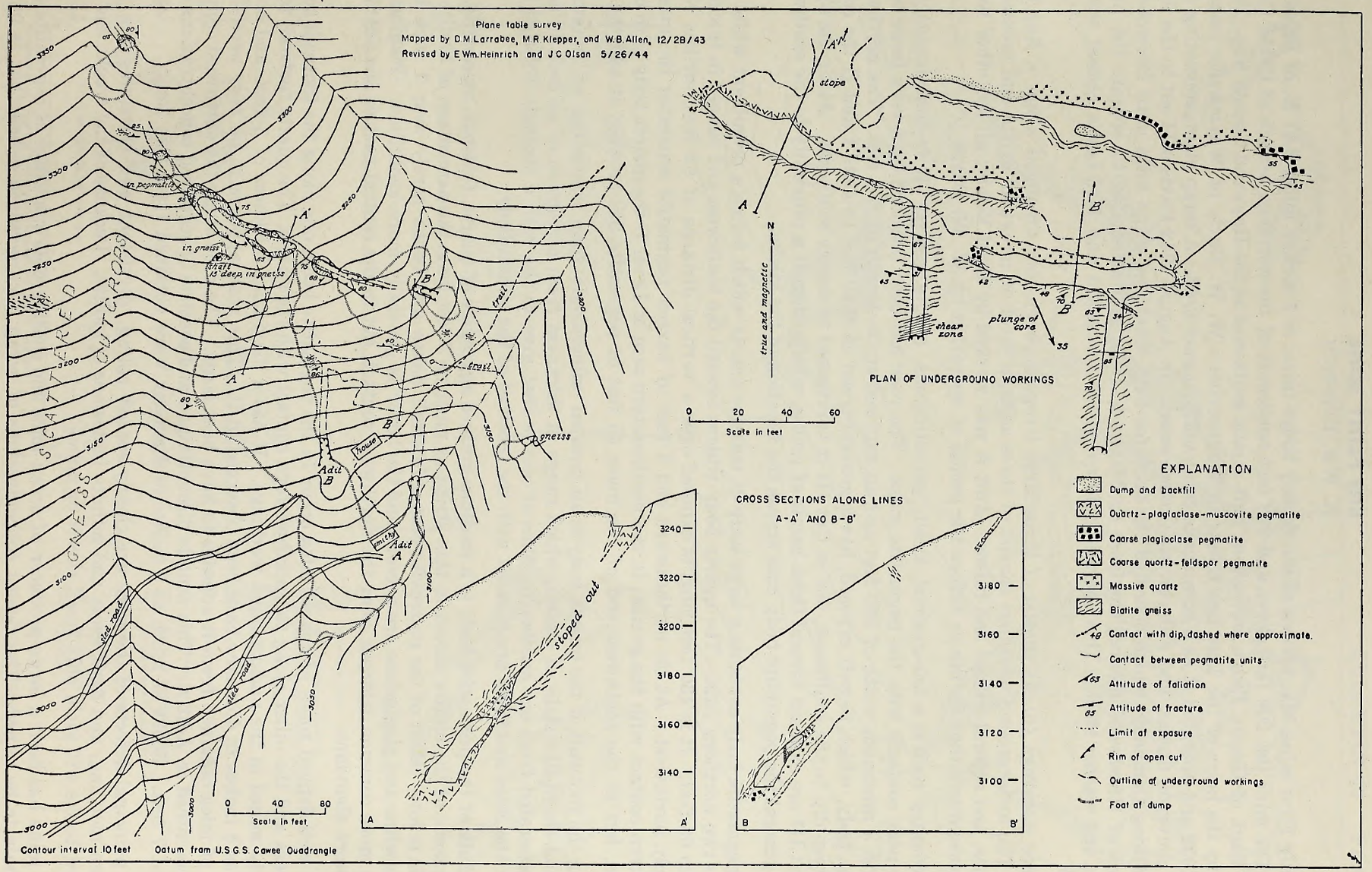
West of the end of the quartz core on Level Z (pl. 5, underground map) the drift passes through a 25-foot zone of hybrid pegmatite which contains numerous inclusions and septa of biotite gneiss. Beyond this zone of hybrid pegmatite the body contains a core of very coarse-grained quartz and feldspar and a rudimentary muscovite zone near the hanging wall. The quartz core also ends near the eastern face of Level Y. Between the end of the quartz core and this face the pegmatite body thins from 7 to 2½ feet, and it may possibly pinch out toward the east.

Muscovite occurs in a well-defined zone between the barren hanging-wall rind and the zone of coarse plagioclase. A thin selvage of muscovite with biotite lies along the hanging-wall side of the quartz core, but this mica is too severely broken to be of strategic value. The lateral extent of the mica zone appears to coincide with that of the quartz core, and both the mica shoot and the core plunge about 35° southeast. Mica books are as much as 2 feet wide and 3 inches thick; ribbons 16 inches long and 5 inches wide were also noted. Ruling, warping, and cracks are the principal defects; "A" structure and mineral inclusions are subordinate. The mica is deep rum and the books are generally hard and flat. Much of it is of very good quality. Flat sheets measuring 6 by 8 inches were trimmed from some of the larger books.

The following estimates and calculations are for the period between December 27, 1943, and May 26, 1944:

Total pegmatite mined	1200 tons
Pegmatite mined per average day	9 tons
Mine-run mica produced per average day	400 pounds
Percentage mica in pegmatite*	2.2%
Total mine-run mica produced	25.5 tons
Total No. 1 and No. 2 sheet and punch mica produced**	6000 pounds
Percentage of No. 1 and No. 2 sheet and punch mica in mine-run, calculated	12%
Percentage No. 1 and No. 2 sheet and punch mica in mine-run, estimated average	8%

*Allowing for loss on dumps.
**Probably includes some mica produced before December 27 and sold after that date.



MAP AND SECTIONS OF THE BEASLEY NO. 2 MINE, MACON COUNTY.

BIG FLINT MINE

E. WM. HEINRICH

The Big Flint mine, also known as the Grassy Ridge mine, is 2 airline miles S.57°E. of Balsam, Jackson County. The mine lies 200 feet above and 300 feet northwest of the northern branch of Cabin Creek on the southeast flank of Grassy Ridge, and about half a mile southwest of the Haywood County line. The property is owned by the heirs of the Tom Lee Estate of Waynesville. W. W. Davis of Waynesville leased the property in 1932 and operated it as a scrap-mica mine until August 1942. A scrap plant, consisting of bins, two crushers, conveyor flumes, and a dryer, was constructed. In August 1942 Davis sold out to the Balsam Mining and Milling Company, which operated the mine for both sheet and scrap mica until December 15, 1943. Fred Lewis of Hazelwood secured the lease on March 1, 1944, and attempted to operate the property for sheet mica and washer stock. This operation did not prove successful and Mr. Lewis ceased work early in May 1944.

Surface workings (pl. 6) consist of three large irregular open-cuts arranged along a line that trends N.65°E. The underground workings consist of three adits, a level of irregular drifts and crosscuts, several large stopes, and several winzes and raises. Adit A was worked by Fred Lewis; all the other workings are old, and were dug either during or before the period of operation by W. W. Davis.

The country rock is a fine-grained, locally garnetiferous, biotite gneiss. It is conspicuously contorted, especially near contacts with the pegmatite mass. The rock has been intruded by a very large body of pegmatite with a minimum width of 300 feet and an explored strike length of 375 feet. The northwestern contact of the body, which is well exposed, has a general trend of N.60°E. In Cuts I and II the contact has a general steep dip to the southwest, but in Cut III it is reversed to steeply southeast. Along the southwestern wall of Cut III are exposed several thick bands of gneiss, which suggest a proximity to the southwestern contact. In general the pegmatite body cuts across the foliation of the gneiss.

The pegmatite body contains a large body of massive quartz which forms a prominent white outcrop between the two northern cuts. The quartz body widens toward the southwest and ranges in thickness from a few feet to 65 feet. It is 130 feet long, is exposed over a vertical distance of 85 feet, strikes N.45°E., and dips steeply northwest. At its northeastern end 4 feet of barren pegmatite separates the mass from the northwestern contact with the gneiss; in the northwestern arm of Level D the quartz body is in contact with the gneiss, but at the southwest end of the mass 45 feet of pegmatite lies between it and the gneiss.

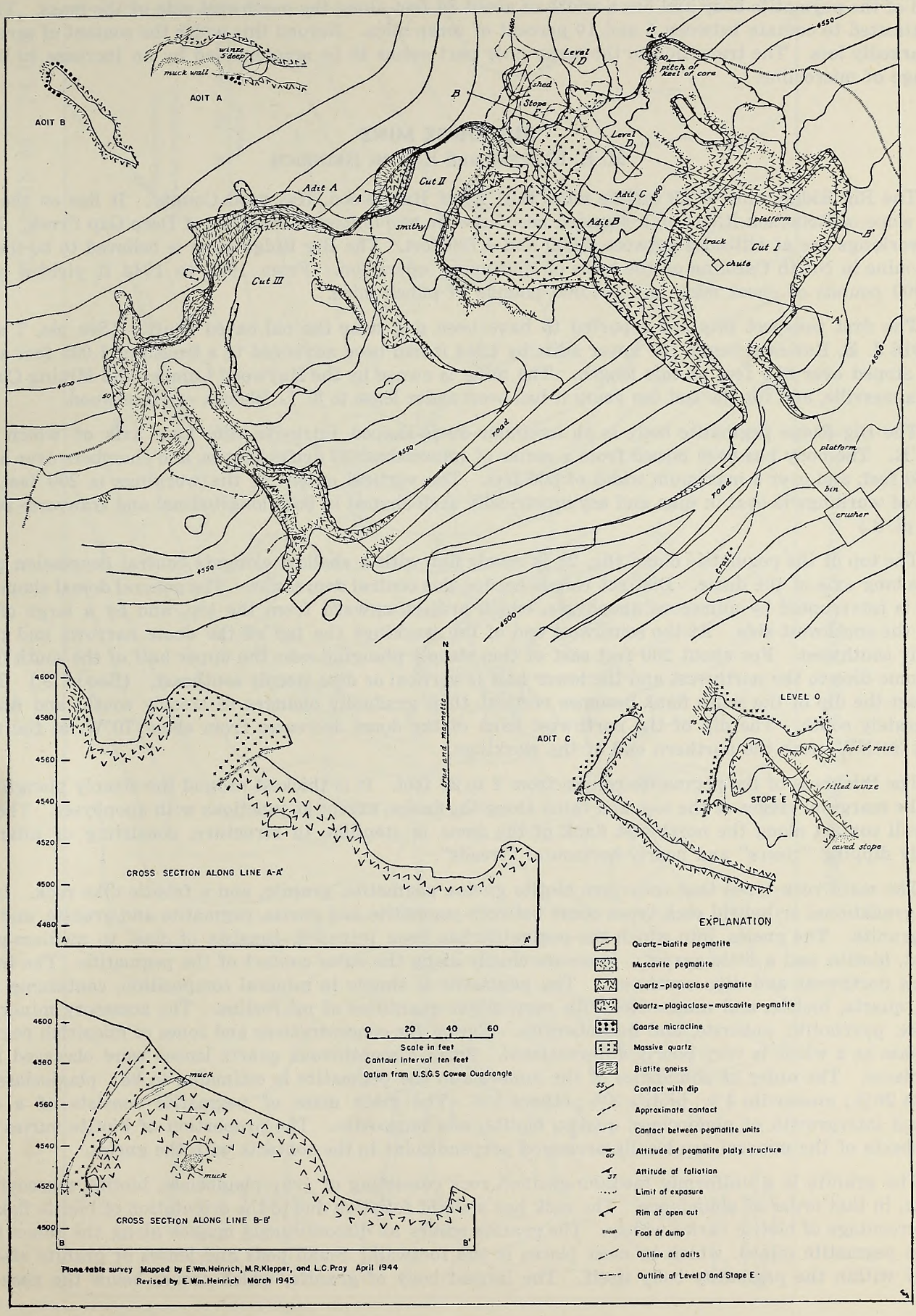
Along the footwall of the quartz body is an unusual mineralogic zone consisting of innumerable subparallel and shard-like slabs of quartz, which range in thickness from a fraction of an inch to nearly a foot and are separated from one another by films of biotite that give to the rock a strongly foliated appearance. Generally the slabs and films are parallel with the footwall of the quartz body.

The bulk of the pegmatite body is a medium-grained aggregate of quartz, feldspar, muscovite, and biotite. Although some of the biotite occurs in thin strips as much as 3 feet long, the percentage of biotite in the body as a whole is low. Most of the muscovite occurs in small flakes and books rarely over 1 inch in diameter. Both microcline and plagioclase are present and the latter is generally more kaolinized. Plagioclase appears to be the more common feldspar near the northwest contact, but in the central part of the pegmatite microcline is more abundant.

Two well-defined zones of coarse mica occur in the pegmatite body, one along the footwall contact of the quartz mass and the other along the northwestern contact with the gneiss. The quartz footwall zone has been extensively mined in the underground workings. It has a maximum thickness of 3 feet, and books of mica as much as 5 inches in diameter have been observed in it. This zone appears to be very persistent and the quantity of mica obtained from it appears to have been large. The zone along the northwest contact with the gneiss was mined in Adit A. This zone is discontinuous and consists of scattered concentrations of mica over a width of 7 feet. Books as much as 9 inches in diameter were obtained from this zone.

The principal defects of the mica are closely-spaced ruling, persistent and through-going fractures, a light-green mottling, and dark spots and minute inclusions of biotite. Because of the cracks and ruling, even the largest books will yield only small sheets or punch.

The mine has been a large producer of scrap mica and considerable quantities of pegmatite rich in scrap mica remain to be mined. The richest concentrations of scrap mica occur in a belt that is parallel to the



Plane-table survey Mapped by E.Wm.Heinrich, M.R.Klepper, and L.C.Pray April 1944
Revised by E.Wm.Heinrich March 1945

MAP AND SECTIONS OF THE BIG FLINT MINE, JACKSON COUNTY.

trend of the pegmatite body and has a width of about 80 feet along the northwest side of the mass. This belt is estimated to contain between 5 and 10 percent of scrap mica. Beyond this width the content of scrap mica is markedly less. The transition to the scrap-poor part seems to be accompanied by an increase in the percentage of microcline.

BIG RIDGE MINE

M. R. KLEPPER and E. WM. HEINRICH

The Big Ridge mine is 3.9 airline miles S.21°E. of Hazelwood, Haywood County. It lies on the southwest slope of Roberson Ridge on a rounded nose between two unnamed branches of Deep Gap Creek. Most of the workings are at altitudes between 4,500 and 4,700 feet. The Big Ridge mine is believed to be the oldest mica mine in North Carolina on the basis of continuous operation. From 1922 to 1944 it yielded at least 436,000 pounds of sheet mica and 807,000 pounds of punch mica.

The first prospect pits are reported to have been dug near the old caved shaft. (See pls. 7 and 8.) In 1915 J. E. Burleson began the lower adit; by 1944 it had been advanced to a length of 1,060 feet and had been stoped over 650 feet of this length. The mine is owned by the Haywood Lumber and Mining Company of Waynesville, and for the last ten years it has been under lease to T. L. Blalock of Hazelwood.

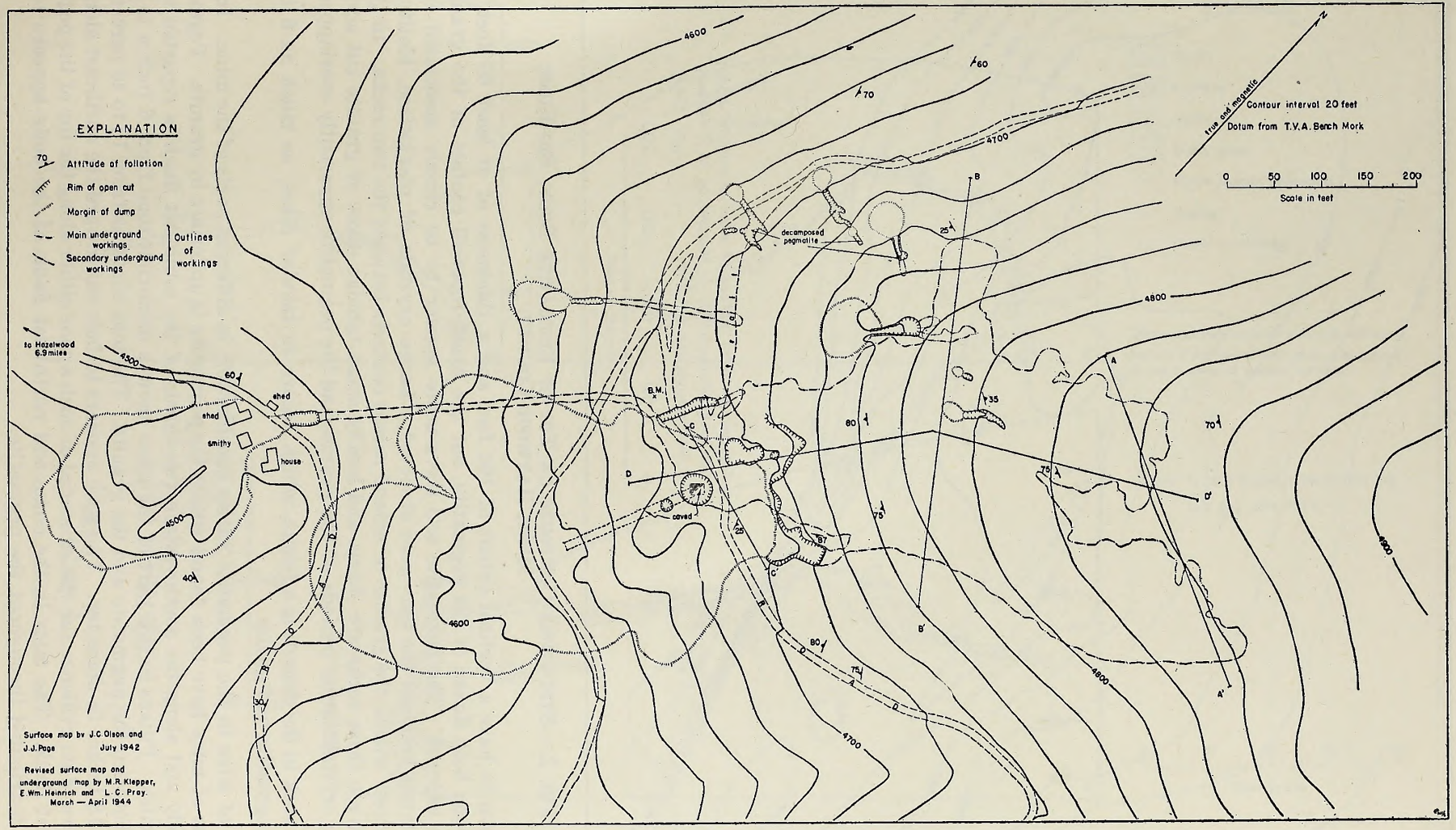
The Big Ridge pegmatite body is an irregular dome-shaped intrusive, the long axis of which trends N.55°E. The body has been mined from a series of interconnected drifts, stopes, and chambers over a length of 650 feet, and over a maximum width of 300 feet. The vertical extent of the workings is 200 feet. This maze of workings is oval in plan and asymmetrically arch-shaped in both longitudinal and tranverse sections. (See pl. 8.)

The top of the pegmatite dome (fig. 2) is nearly flat with a shallow elongate central depression parallel to the long axis of the dome. Distinct ridges border this central depression. The general domal shape of the mass is interrupted by numerous apophyses, which project upward from the top, and by a large off-shoot from the southwest side. At the southwest end of the workings the top of the dome narrows and plunges steeply southwest. For about 200 feet east of this steeply plunging nose the upper half of the south flank of the dome dips to the northwest and the lower half is vertical or dips steeply southeast. (See pl. 8.) Toward the east the dip of the south flank becomes vertical, then gradually changes to steeply south, and finally to moderately south. The dip of the northwest flank of the dome decreases from about 70°W. at the nose to about 30°NW. near the northern end of the workings.

The thickness of the pegmatite ranges from 2 to 25 feet. It is thickest around the steeply plunging nose and the marginal ridges of the top, and thins along the flanks, except at junctions with apophyses. The hanging-wall contact along the northwest flank of the dome is step-like in structure, consisting of alternating steeply dipping "risers" and nearly horizontal "treads".

The main rock types that occur are biotite gneiss, pegmatite, granite, and a felsitic dike rock. In addition, gradational or hybrid rock types occur between pegmatite and gneiss, pegmatite and granite, and gneiss and granite. The gneiss, into which the pegmatite has been intruded, consists of fine- to medium-grained quartz, biotite, and a little garnet. It occurs chiefly along the outer contact of the pegmatite. The foliation strikes northwest and dips southwest. The pegmatite is simple in mineral composition, containing plagioclase, quartz, biotite, and muscovite, with very minor quantities of microcline. The accessory minerals are apatite, pyrrhotite, ankerite, and hedenbergite. Except for concentrations and zones of mica-rich pegmatite, the mass as a whole is very poorly differentiated. Small discontinuous quartz lenses were observed in only two places. The order of abundance of the minerals in the pegmatite is estimated to be: plagioclase 73%; quartz 20%; muscovite 3%; biotite 3%; others 1%. The main mass of pegmatite consists of a coarse-grained intergrowth of plagioclase, quartz, biotite, and muscovite. The proportion of biotite varies widely and sheets of the mineral are locally arranged perpendicular to the contacts with the gneiss.

The granite is a uniformly medium-grained rock consisting of gray plagioclase, biotite, muscovite, and quartz, in that order of abundance. The rock has a slight foliation due to the orientation of biotite flakes, but the percentage of biotite varies widely. The granite occurs as discontinuous masses along the inner margin of the pegmatite mined, which in most places is the footwall. Small pods and lenses of granite also occur locally within the pegmatite body itself. The largest body of granite, which occurs below the nose of the



MAP OF THE BIG RIDGE MINE, HAYWOOD COUNTY.

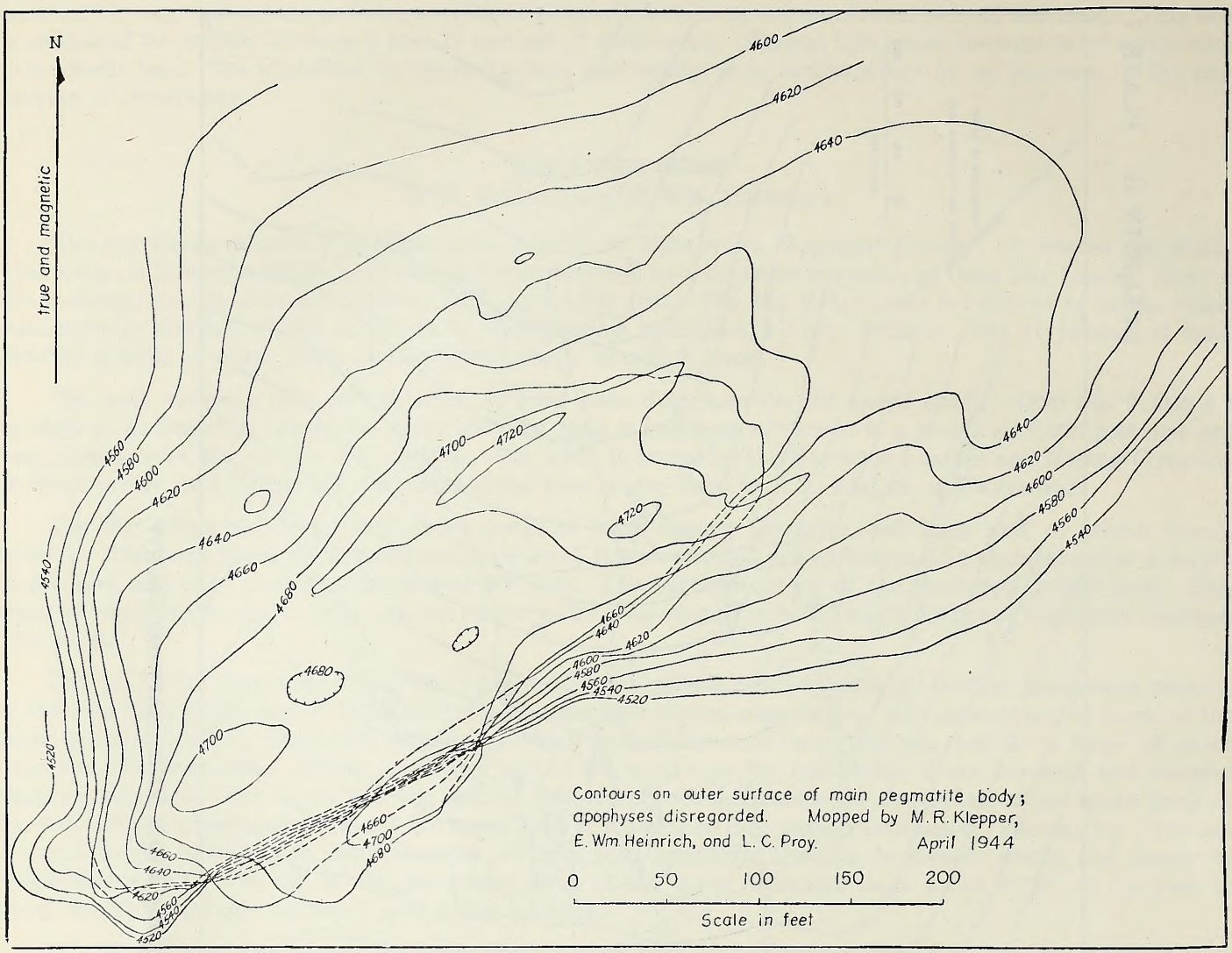
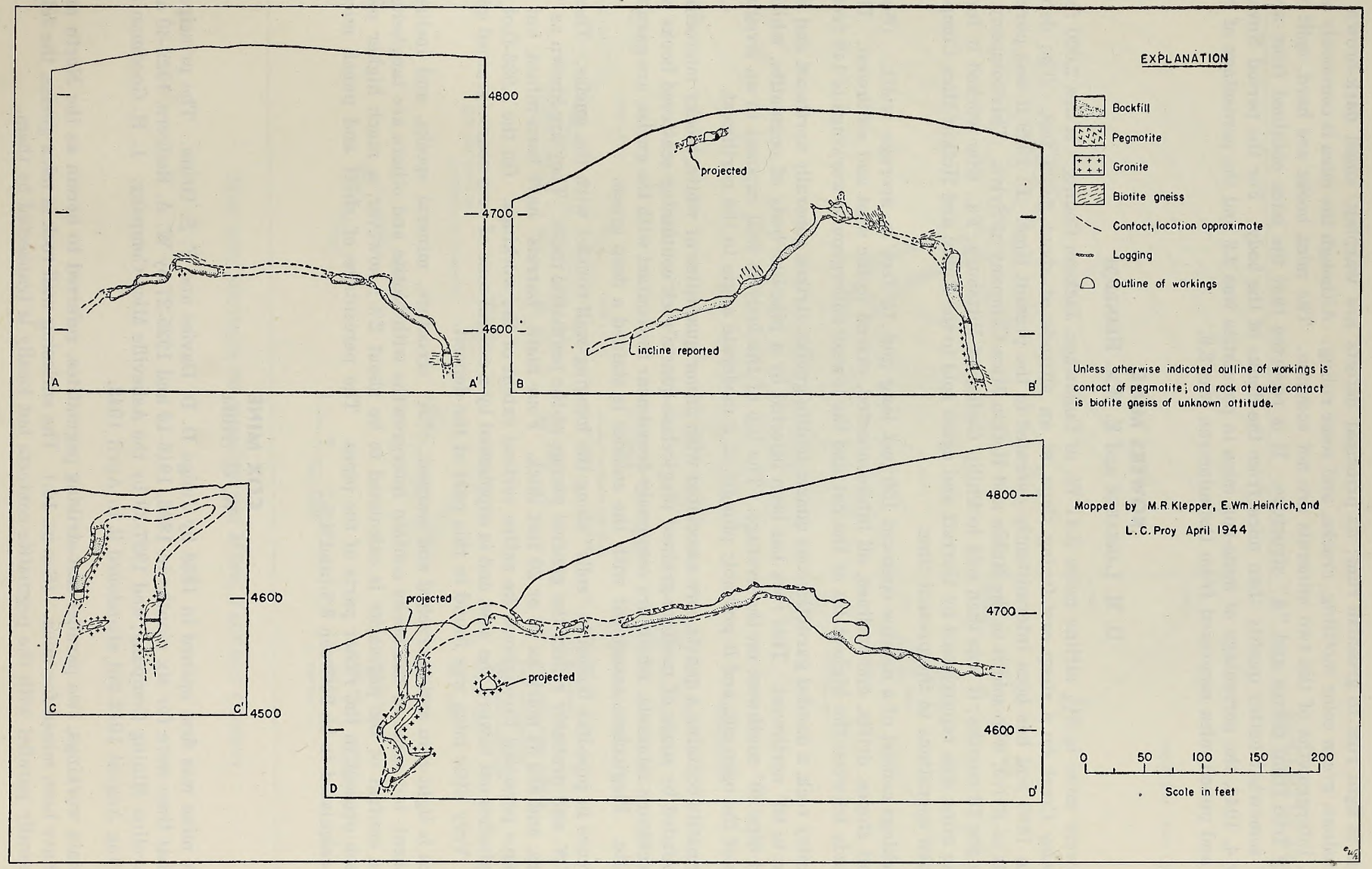


FIG. 2.—STRUCTURE CONTOURS ON TOP OF PEGMATITE BODY, BIG RIDGE MINE, HAYWOOD COUNTY.

pegmatite, is known to have a vertical extent of 100 feet and a thickness of at least 60 feet. This mass appears to thin along both flanks of the pegmatite, but the exact footwall contact of the granite with the gneiss is nowhere exposed. The pegmatite and the granite appear to be closely associated in origin, as transitional rock types between the two were observed. Large crystals of plagioclase, biotite, muscovite, and apatite lie entirely within the granite or extend across contacts between the two rocks. In general, however, contacts between these rocks are sharp, and locally small tabular dikes of granite cut across the pegmatite body. The crystallization periods of the granite and the pegmatite apparently overlapped.

The youngest rock in the deposit is a felsite, which occurs in tabular dikes, as much as 6 inches thick, transecting both pegmatite and gneiss.

The quantity of mica in the pegmatite varies considerably in different parts of the mine. In general the best concentrations of mica have been found where the pegmatite is underlain by granite. Pegmatite around the nose of the body and along the southwestern two-thirds of the southeast flank is reported to have been unusually rich in mica. Pillars in this part of the mine show a mica-rich zone from 6 inches to 2 feet thick along the contact between the pegmatite and the granite. The zone contains from 10 to 40 percent of mica in books as much as 18 inches in diameter. The zone appears to fade out toward the northeast along the southeast flank, and there is no evidence for the existence of such a zone either along the top of the pegmatite dome or in the northwest flank. The mica in the dome and northwest flank of the body appears to have been rather uniformly distributed throughout the pegmatite.



SECTIONS OF THE BIG RIDGE MINE, HAYWOOD COUNTY.

The mica is light rum to greenish rum; its principal defects are warping, small dark-brown to black mineral inclusions, green color mottling, cracks, and some ruling. Although the mica is commonly associated with biotite, intergrowths of the two minerals are not common. The mica books are hard, split well, and are generally free from reeves and "A" structure. It is reported that the mica obtained from around the nose was of somewhat better quality than mica from the flanks of the body. For the period November 10, 1942 to May 4, 1944, the percentage of mine-run mica in pegmatite was 2.8 and the percentage of No. 1 and No. 2 sheet and punch mica recovered from the mine-run was 8.6.

BOWERS MINE

D. M. LARRABEE and E. WM. HEINRICH

The Bowers mine is 3½ airline miles S.41°W. of Cullowhee, Jackson County. It lies 2,000 feet northwest of Presley Creek on a steep east-facing slope, at an altitude of about 3,000 feet. The deposit was discovered in 1899 and has been intermittently operated to the present time. In 1929 it was purchased by R. U. Garrett of Sylva, who sold it to the Rubin and Hetkin Mica Company of Sylva. This company operated the property for 18 months; it was then sold to Philip Godley of Pittsburg, Pa., who worked it for about 6 months. The mine was repurchased by Garrett and again sold to the Rubin and Hetkin Mica Company, who have continued operations to the present time.

The workings consist of a narrow open-cut 150 feet long and 15 feet in average width. (See pl. 9.) From this cut stopes, drifts, and inclines, all interconnected, extend to the west and southwest. The difference in altitude between the highest lip of the cut and the lowest underground workings is 140 feet.

The country rock, a banded garnetiferous quartz-biotite gneiss, strikes generally northeast and dips from 80° southeast to 60° northwest. This rock has been injected by a pipe-like body of pegmatite, which strikes N.35°W. and dips 80° southwest on the average. The top of the body is well exposed in an irregular drift from the top of the open cut, and it probably plunges at a moderate angle to the northwest.

The pegmatite contains a quartz core associated with minor quantities of white, blocky microcline. This core is surrounded by zones of medium-grained plagioclase-quartz rock containing scattered books of muscovite. The accessory minerals, which are commonly found near the contact with the gneiss, are garnet, pyrite, and pyrrhotite. Plagioclase associated with the sulfides is stained a deep green.

Mica occurs in pipe-like bodies in "rolls" along the hanging-wall contact with the gneiss. These bodies plunge 45°NW. and probably reflect the general plunge of the pegmatite mass. They are known as "barrels" by the miners, and are as much as 15 or 20 feet thick. Four main "barrels" have been mined, but only one appears to have persisted throughout the entire vertical extent of the workings. On the 2,936-foot level the quartz core pinches out toward the west and is supplanted by a central zone of very coarse-grained quartz and plagioclase. Very little mica was found in this part of the deposit.

The mica is light rum and is cracked and warped. "A" structure, mineral specks, and inclusions are generally absent, but some of the books contain intergrowths with biotite and others are tanglesheet. The average mica content of the pegmatite is calculated to be about 2%; however, a much higher percentage may have been present in the richer parts of the pipes. The percentage of sheet and punch mica in the mine-run is calculated to be between 3% and 4%.

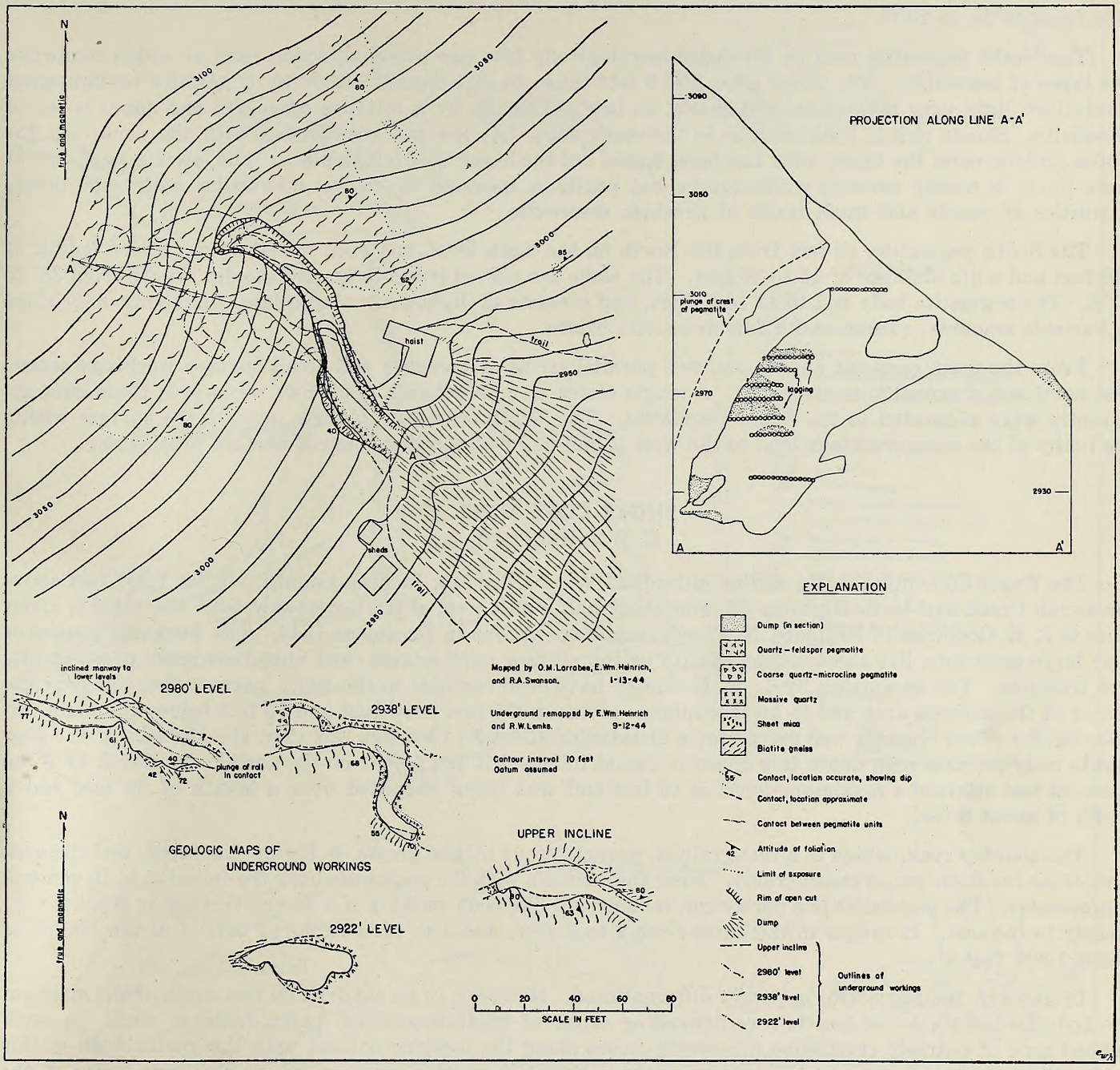
COX MINE

W. C. STOLL

The Cox mine was first opened in 1868 by Judge D. D. Davies and F. S. Orum. The principal operations since that time were for six months in 1896, 1916-19 and 1925-27 by W. A. Rodgers, 1929-30 and 1935-37 by the Carolina Mining Company, and 1937-39 by the Asheville Mica Company. L. H. Goodman reopened the mine during August 1942 but abandoned it in April 1943.

In the main workings, two parallel east-striking pegmatites, referred to herein as the North and South pegmatites, have been mined for mica. (See pl. 10.) The enclosing wall rock is mica gneiss, the foliation of which is generally parallel with the pegmatite contacts but locally is transected by them.

BULLETIN 49 PLATE 9



MAP AND SECTIONS OF THE BOWERS MINE, JACKSON COUNTY.

The North pegmatite has been developed over a strike length of 220 feet and a width of 30 to 60 feet, in an open pit and in underground stopes. The upper contact of this body has the form of an anticline, the crest of which pitches 10 degrees in a S.68°W. direction. The axes of minor crenulations in the gneiss pitch parallel to the main structure. The south limb of the anticline dips 50°-60°S., and the north limb, where observed, dips from 40°N. to 70°S.

The North pegmatite may be divided mineralogically into two principal zones, each of which comprises two types of pegmatite. The upper zone, 2 to 8 feet thick, is represented either by a mixture of light-gray plagioclase, light-gray microcline, and quartz or, less commonly, by a mixture of quartz and small books of muscovite. Shoots rich in book mica lie in the upper zone, but are not coextensive with the zone. In the stopes underground the upper zone has been mined but the lower zone left in place. The lower zone, 6 feet or more thick, is mostly massive white quartz, but partly a mixture of coarse microcline with subordinate quantities of quartz and small scales of greenish muscovite.

The South pegmatite, 40 feet from the North on the main level, has been mined over a strike length of 120 feet and a dip distance of 15 to 30 feet. The walls are curved irregularly, and the dip ranges from 35° to 70°S. The pegmatite body is 7 to 12 feet thick, and consists of light-gray plagioclase, light-gray microcline in variable amounts, quartz, and a few muscovite blocks.

From the main open-cut and stopes, two parallel series of trenches and small surface workings extend east-northeast diagonally up the slope. A single series of cuts extends 1,000 feet westward; these cuts apparently were excavated in the South pegmatite. The North pegmatite plunges beneath the surface within the limits of the main workings, and to the west it lies well beneath the range of surface prospecting.

ENGLE COPE MINE

E. WM. HEINRICH

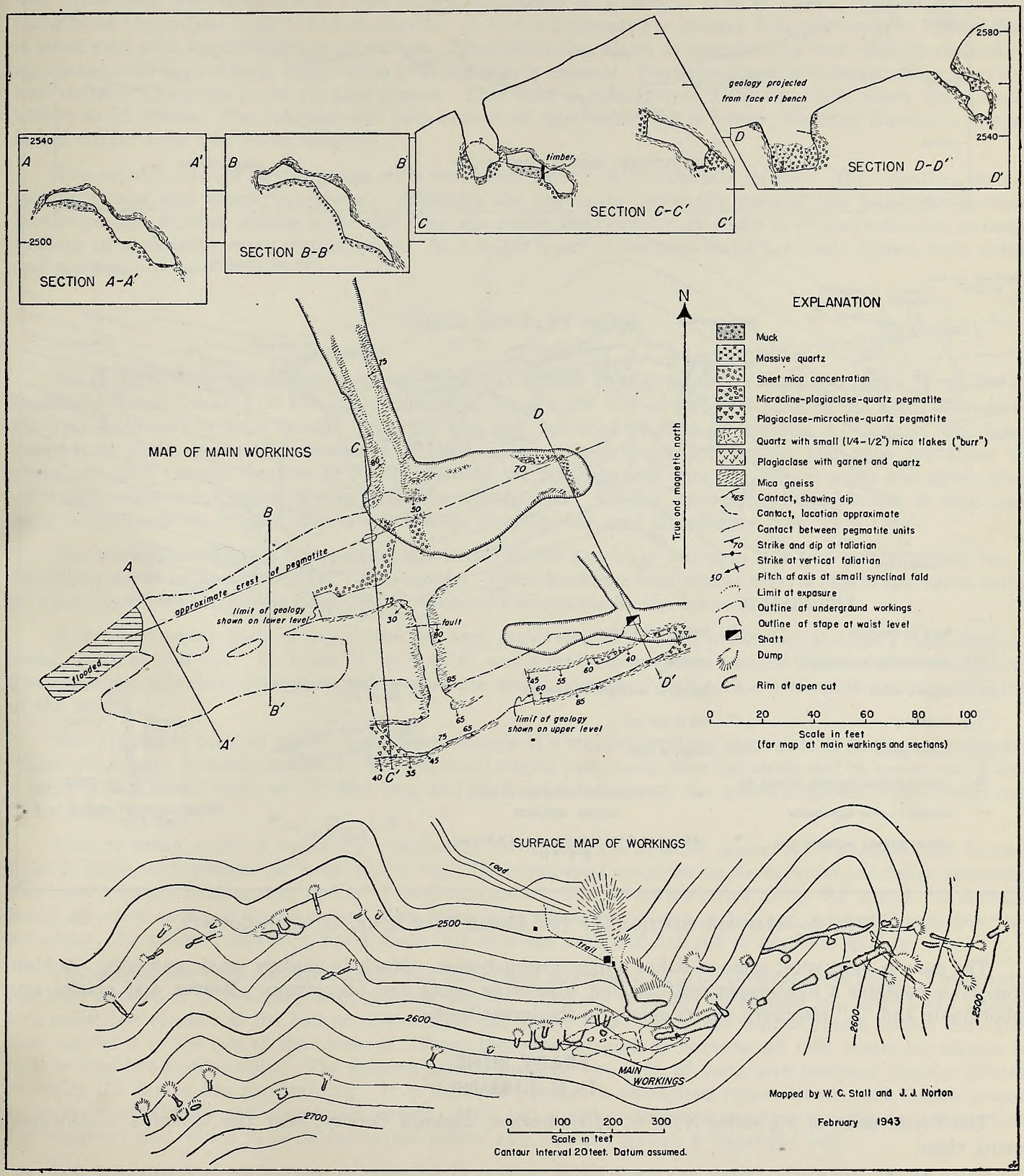
The Engle Cope mine is 7½ airline miles S.23°W. of Dillsboro, Jackson County. It lies 1,200 feet above Savannah Creek and U. S. Highway 23, and about half a mile west of the Cowee sawmill. The mine is under lease to L. H. Goodman of Biltmore, N. C., who began operations in December 1943. The workings consist of four large open-cuts, five short crosscuts with drifts, all now partly caved, and numerous small prospect pits and trenches. The operations by L. H. Goodman have been confined to the large, narrow open-cut near the center of the mapped area and to an incompleted crosscut 275 feet northeast and 75 feet below this main cut. (See fig. 3.) This crosscut was driven for a distance of about 80 feet, but was then abandoned. If the pegmatite body persists with depth this crosscut should intersect it 120 feet from the portal. In March 1944 the open-cut had attained a maximum depth of 16 feet and was being deepened over a length of 30 feet and a width of about 5 feet.

The country rock, which is a fine-grained, garnetiferous biotite gneiss, is highly fractured, and the attitude of its foliation varies considerably. Near the contacts with the pegmatite body the foliation is, in general, conformable. The pegmatite is a persistent, tabular, sill-like body striking N.5°E. and vertical or dipping very steeply to the east. It ranges in thickness from 2 to 8 feet, and has been explored over a strike length of about 1,000 feet.

In general, the pegmatite is poorly differentiated. However, in an old drift 60 feet south of the main cut the body contains a 4-foot quartz core flanked by zones of medium-grained quartz-feldspar rock. A well-defined zone of coarsely crystalline muscovite occurs along the western contact with the gneiss, both in this drift and in the main open-cut. The quartz core is absent from the open-cut, where the main mass of the body consists of a uniformly medium- to coarse-grained intergrowth of quartz and plagioclase. Near the west-wall mica zone much of the plagioclase is partly replaced by dark-green sericite. Small red garnets and small blebs and veinlets of pyrrhotite occur sparingly in the plagioclase. Near the contacts with the pegmatite body the gneiss contains thin films of both pyrite and pyrrhotite.

Mica occurs in a west-wall (generally the hanging-wall) zone. This zone, which is well defined both in the main open cut and in the old drift south of the cut, is poorly defined in the workings at the northern end of the area. In the cut this zone has a maximum width of 2 feet and books of mica as much as 7 inches in diameter were observed in it. At the north end of the cut this zone was estimated to contain between 5 and 8 percent of book mica.

BULLETIN 49 PLATE 10



MAP AND SECTIONS OF THE COX MINE, JACKSON COUNTY.

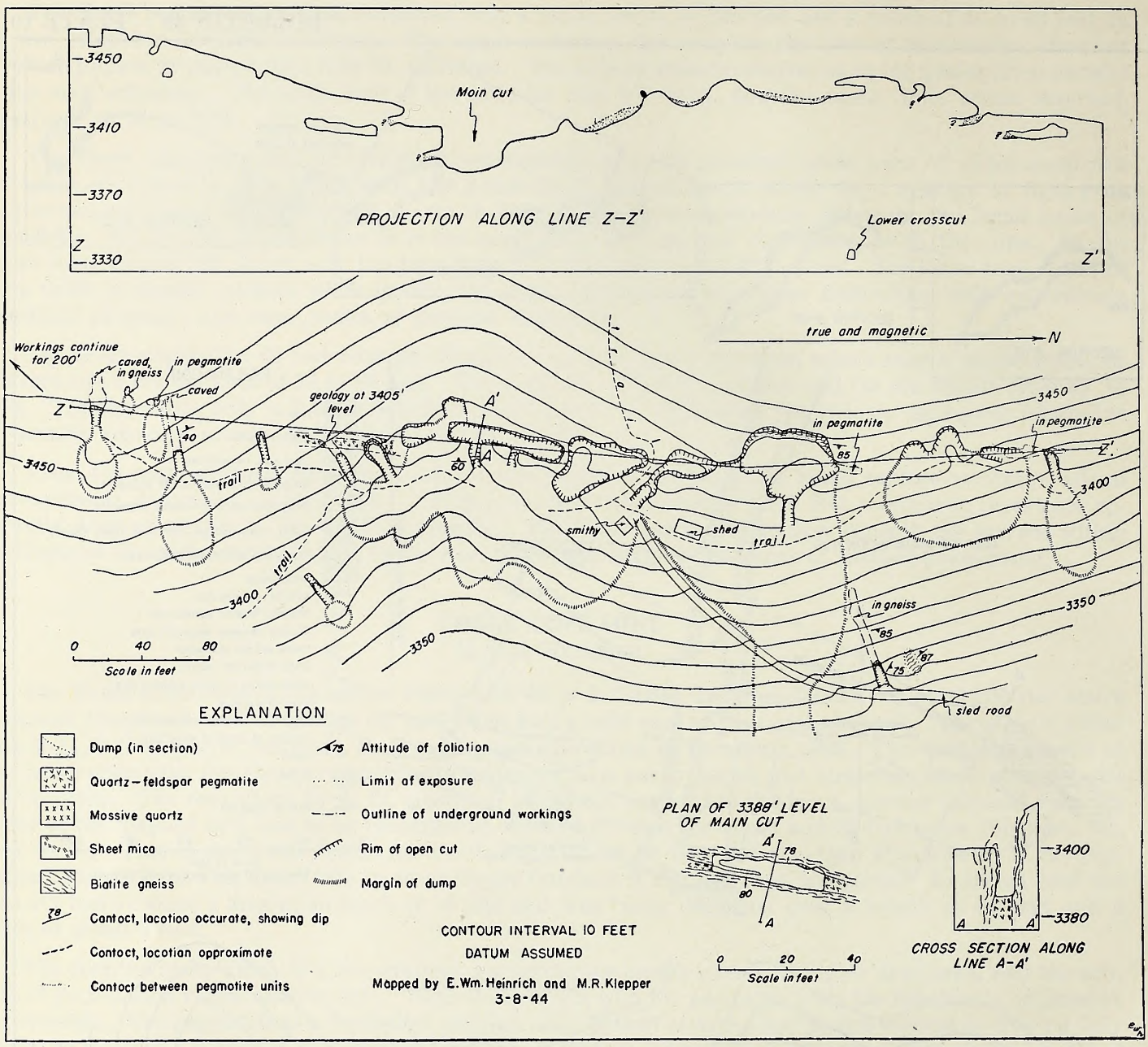


FIG. 3.—MAP AND SECTIONS OF THE ENGLE COPE MINE, JACKSON COUNTY.

The mica is light rum; some of it has a light-greenish cast. Much is slightly wavy and soft. A high proportion contains a light-green mottling, but iron oxide spots are uncommon. Reeves and cracks are subordinate and "A" structure occurs chiefly in the larger books.

FRADY MINE

D. M. LARRABEE

The Frady mine is 3½ miles N.85°W. of Cullowhee, Jackson County, near the top of a northward-facing ridge.

The mine is said to have been opened about 60 years ago by C. and E. Bowers, of Webster. M. D. Cowan, the present owner, has operated the mine from October 1942 to the present (October 1944). Development consists of a main adit, the Bowers adit, several short adits, stopes, and open cuts, and shafts to a depth of 135 feet. These workings form a series 650 feet long trending about N.60°W.

Three pegmatite bodies are exposed on the property, but nearly all of the mica has been obtained from one. This main pegmatite is 4 to 8 feet thick and consists of a central core of quartz flanked by narrow margins of plagioclase, quartz, and muscovite. A few red garnets are present near the contacts. Microcline is associated with the central quartz masses. The muscovite, which is rum to ruby and slightly stained, is associated with the contacts rather than with the quartz masses. The mica zones are richest along the footwall contact, where the books are also largest. This zone is richest over a 6-inch width which occasionally widens to 12 inches. The hanging-wall mica zone is of equal width but is leaner; the mica therein is smaller but of darker color and better quality.

The country rock is biotite gneiss with occasional layers of hornblende gneiss. The foliation strikes northwest and dips steeply northeast. Although the pegmatites generally parallel the foliation, trending northwest and dipping steeply northeast, they are locally discordant. All rocks have been subjected to much faulting of apparently small displacement. As a result many of the mica books are badly folded, bent, ruled, and warped.

IOTLA-BRADLEY MINE

D. M. LARRABEE

The Iotla-Bradley mine (also known as the Iotla or Iotla Bridge mine) is 4 airline miles N. 10°W. of Franklin, Macon County. It lies at an altitude of about 2,000 feet on the west bank of the Little Tennessee River at the mouth of Iotla Creek. The mine was first operated in 1905 by Francis A. Gudger, who later leased it to the Southern Mica Company. This company mined it for both kaolin and mica for about 10 years. In 1935 Charles Bradley of Franklin leased the property and operated it as a scrap and sheet mine until 1940, when the Bradley Mining Company was formed. Bradley relinquished his interest in this company in 1944 and the present officers are Messrs. Preston, Lee, and Zieseniss of New York City.

The workings consist of a large open-cut which is 800 feet long, averages 200 feet in width, and has a maximum depth of about 160 feet. (See fig. 4.) Older workings consisted of several shafts and adits, many of which have been completely destroyed or rendered inaccessible by the open-cut operation.

A large irregular body of pegmatite has been explored over a length of 800 feet and has a maximum exposed width of 200 feet. It trends N. to N.30°E. and is vertical, cutting across the foliation of biotite gneiss. The walls are extremely irregular, and large septa and inclusions of wall rock are common near the margins of the mass.

The pegmatite body is poorly zoned and consists of a medium-grained aggregate of kaolinized feldspar, muscovite, quartz, and a little biotite. Several small quartz pods occur near the south end of the open-cut and a large quartz rib as much as 120 feet long and 15 feet thick lies near the western contact at the north end of the main open-cut.

Mica of scrap grade is uniformly distributed throughout the mass of pegmatite, but sheet mica is confined to zones surrounding the large quartz rib. The scrap mica occurs in scattered books and flakes generally less than 2 inches in diameter, and is of deep-rum color. The mica-rich zones along the quartz rib contain books as much as 2 feet in diameter. This mica is of deep-rum color, is ruled, and some of it contains "A" structure. In general, however, books from this zone are hard and flat and of excellent quality.

The deposit has been operated chiefly for kaolin and scrap mica with by-product sheet mica. The quarry has been developed by benching with gasoline shovels. The ore is loaded by shovels into trucks and hauled to a small jaw crusher at the bottom of the main pit, where it is broken and washed into a bucket conveyor that carries it to the rim of the open-cut. From there the ore goes by flume to the mill, where the stream is split to feed two similar units. The material passes through two sets of rolls and trommel screens before reaching the drying bin for draining. It is then put through a wood-fired rotary dryer, and thence passes to another set of rolls and a trommel screen. Mica to be sold as jigged scrap goes directly to storage bins for bagging; that which is to be pulverized before sale passes through a Raymond mill.

The production of scrap mica is reported to average 3,000 tons per year. Mica constitutes about 10 percent of the rock moved. Sheet mica production was considerably curtailed after June 1944 because the sheet mica zones were partly covered by large slides of material from the walls of the cut. Selected mine-run mica from the mica-rich zones contains about 8 percent of sheet and punch mica.

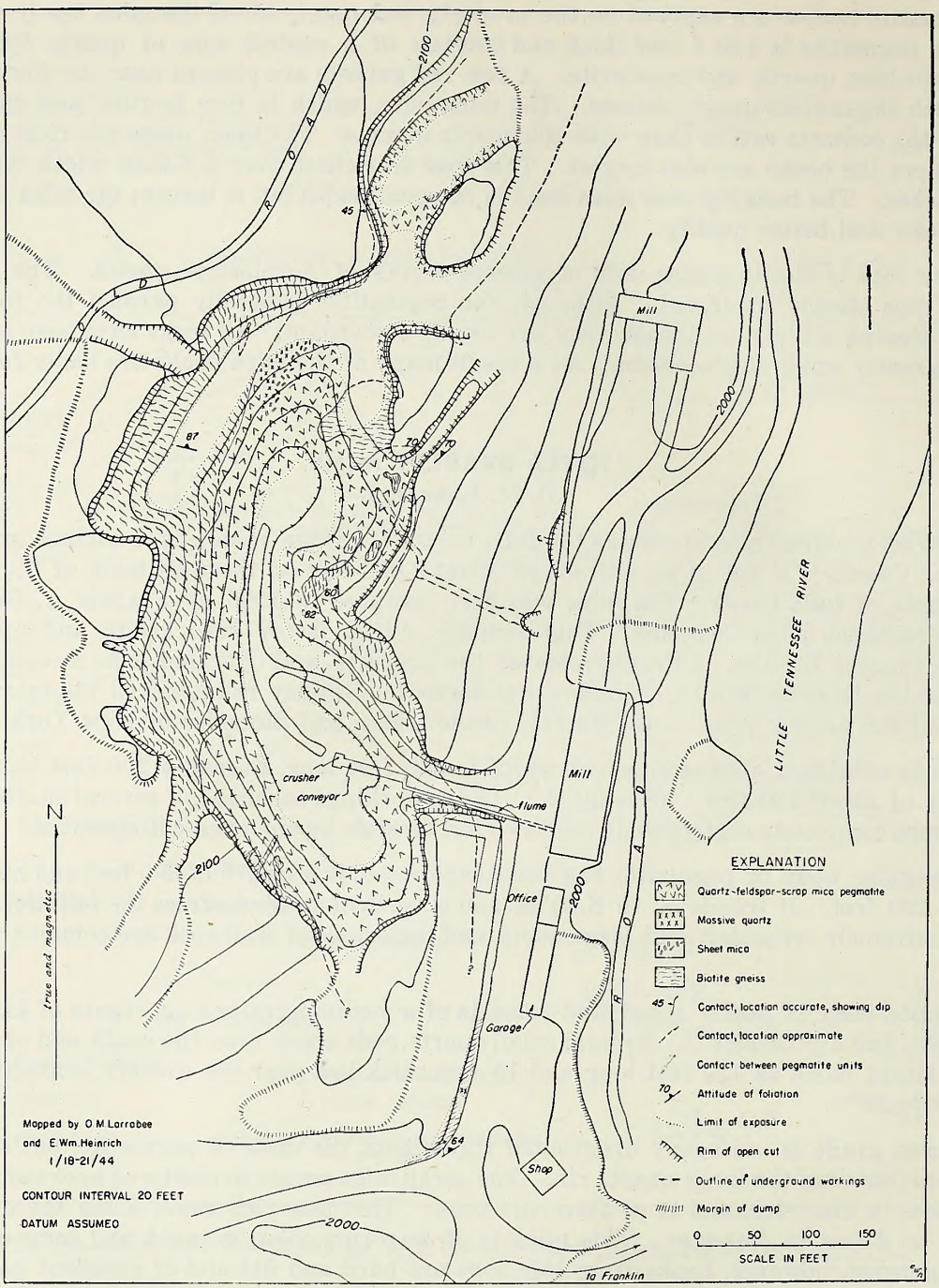


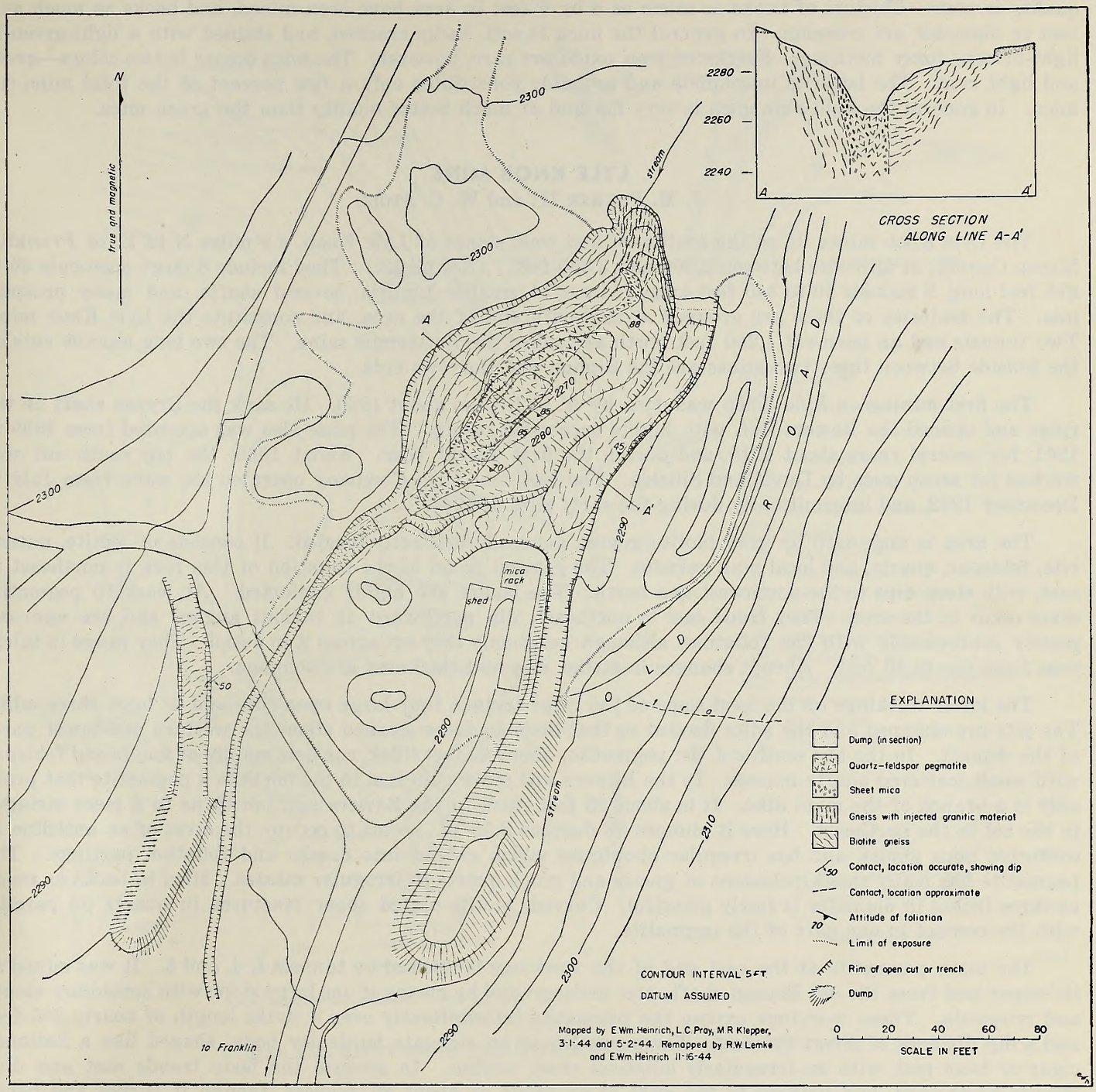
FIG. 4.—MAP OF THE IOTLA-BRADLEY MINE, MACON COUNTY.

KISER MINE

E. WM. HEINRICH

The Kiser mine is 4 airline miles S.87°W. of Franklin, Macon County, at an altitude of 2,300 feet on the west side of a small tributary of Mill Creek. The mine is owned by J. Burn Kiser of Route 1, Franklin, and only prospecting was done before 1942. George Scott of Franklin operated the mine from November 19, 1942 to May 8, 1944, at which time A. W. Reid of Franklin secured the lease and continued operations until late November 1944.

The workings (pl. 11) consist of an open-cut 145 feet long, 65 feet in maximum width, and 35 feet in maximum depth, and a shallow bulldozer trench to the south. Both the country rock and pegmatite are decomposed, and large slides from the walls of the cut are common.



MAP AND SECTIONS OF THE KISER MINE, MACON COUNTY.

The open-cut exposes a single pegmatite body that strikes N.45°E. and appears to be vertical. The country rock is a fine-grained biotite gneiss, whose vertical foliation strikes a few degrees north of west. The pegmatite cuts across the foliation, and the contacts between the two rocks are irregular in detail. The pegmatite mass has a maximum thickness of 25 feet, and has been exposed over a distance of 250 feet. At the north end of the cut it pinches out in a hook-shaped nose and is supplanted along its trend by a zone of gneiss impregnated with many small pods and stringers of pegmatitic material.

The pegmatite is a medium- to coarse-grained intergrowth of quartz, feldspar, and muscovite. Biotite is rare. Muscovite occurs in zones along both walls. The quantity of mica is unusually large, but the general

quality is poor. Clusters of books as much as 4 by 6 feet in area have been mined, and books as much as 1 foot in diameter are common. In general the mica is soft, badly cracked, and stained with a light-green to light-brown, fuzzy mottling. Specks of iron oxide are rare, however. The mica occurs in two colors—green and light rum. The latter is uncommon and probably constitutes only a few percent of the total mine-run mica. In general the light-rum mica is very flat and of much better quality than the green mica.

LYLE KNOB MINE

J. M. PARKER III and W. C. STOLL

The Lyle Knob mines lie on the southwest and west slopes of Lyle Knob, 4.9 miles N.12°E. of Franklin, Macon County, at altitudes between 2,900 and 3,300 feet. (See pl. 12.) They include 8 large open-cuts 40 to 275 feet long, 9 tunnels 50 to 340 feet long, at least 14 smaller tunnels, several shafts, and many prospect pits. The majority of these are grouped at the south end of the area, and constitute the Lyle Knob mine. Two tunnels and an open-cut 1,200 feet north are called the Buttermilk mine. The two long narrow cuts on the hillside between these two mines are the Siphon and Borrows cuts.

The first mining on Lyle Knob was done by A. S. Bryson about 1880. He sank the Bryson shaft on the ridge and opened the Bowers Cut, with highly successful results. The mine also was operated from 1899 to 1901, for several years about 1910, and during the first World War. About 1935, the big south cut was worked for scrap mica by Duval and Shields. The National Mica Company operated the mine from July to December 1942, and intermittently during the early part of 1943.

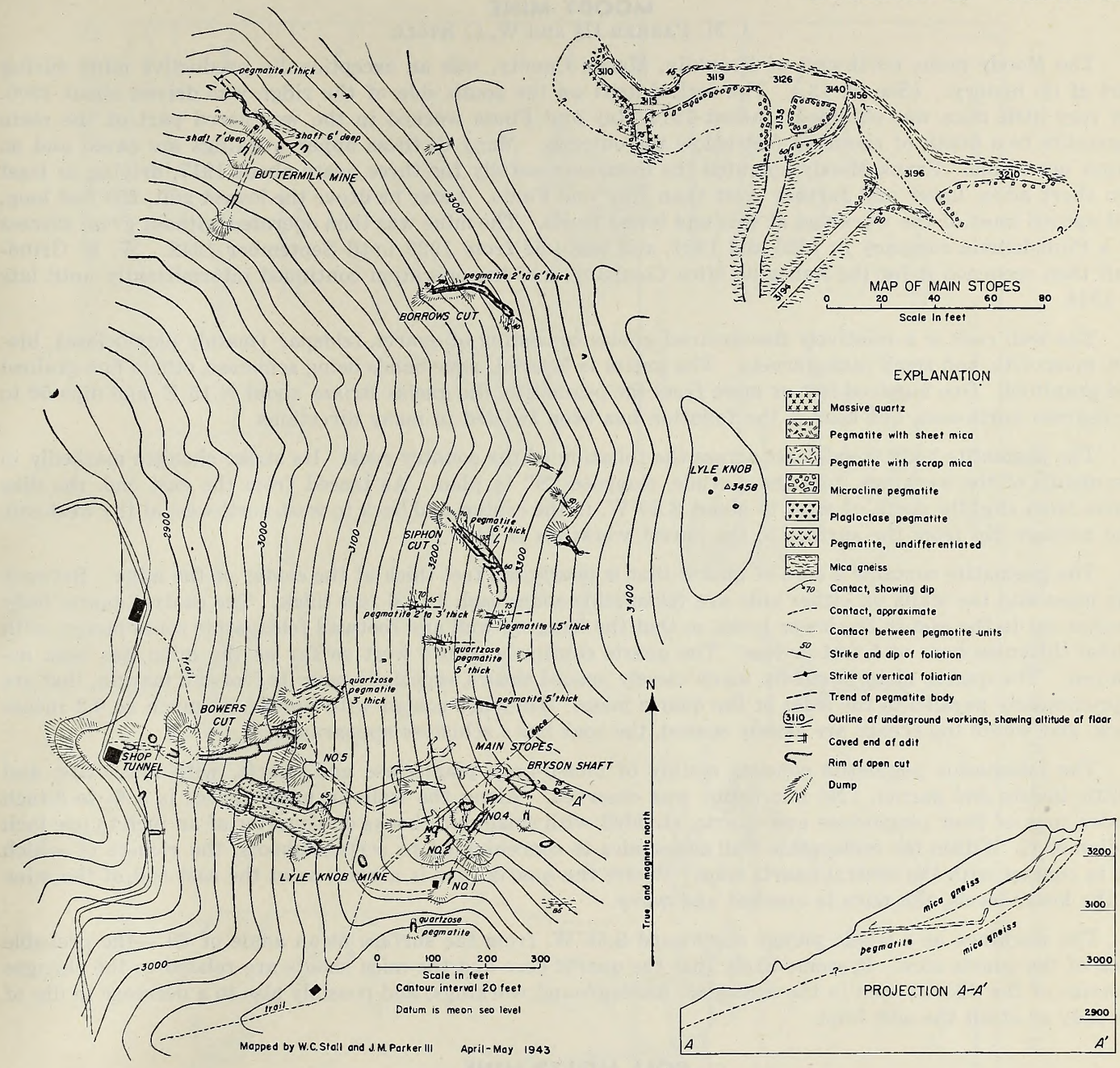
The area is underlain by gray biotite gneiss, generally distinctly banded. It consists of biotite, muscovite, feldspar, quartz, and local pink garnets. The general trend of the foliation of this rock is northeast to east, with steep dips to the northwest and north. The layers are highly contorted. At least 10 pegmatite dikes occur in the area. They trend east to northeast, dip northward at various angles, and are approximately conformable with the foliation, although commonly they cut across it in detail. They range in thickness from one to 40 feet. Abrupt changes in strike, dip, and thickness are common.

The lower workings on the west slope of the ridge include four large open-cuts and at least three adits. The pits are slumped and the adits flooded so that little could be learned about the western and lower parts of the deposit. In the big south cut the pegmatite, about 40 feet thick, consists mainly of kaolinized feldspar with small scattered quartz masses. In the Bowers and other cuts just to the north is a pegmatite that probably is a branch of the main dike. It is about 25 feet thick in the Bowers cut, but thins to a mere stringer in the cut to the northeast. Here it plunges 35 degrees S.55°W., seems to occupy the crest of an anticline in contorted mica gneiss, and has irregular apophyses which extend into cracks and foliation partings. The pegmatite has many small inclusions of gneiss and much quartz in irregular masses. Mica in books as much as three inches in diameter is fairly plentiful. Curved, biotite-coated shear fractures in quartz lie parallel with the contact in one part of the pegmatite.

The main pegmatite at the east end of the workings is reached by tunnels 1, 4, and 5. It was mined at its upper end from the old Bryson shaft, and underground by means of one large stope with subsidiary stopes and crosscuts. These workings expose the pegmatite intermittently over a strike length of nearly 300 feet and a dip distance of about 100 feet. The pegmatite is an elongate lenticular body, shaped like a flattened cigar or bean pod, with an irregularly elliptical cross section. In general the body trends east and dips steeply northward, and plunges to the west at an angle of about 25 degrees, though it curves and bends abruptly at several places. The upper end is exposed in the Bryson shaft and the top edge is also exposed in the big south cut. The shorter axis of the elliptical cross section ranges from 15 to 30 feet, and the longer is about four times as great.

The pegmatite is composed of plagioclase, microcline, quartz, muscovite, biotite, garnet, and pyrite. The plagioclase is white and is generally altered to soft kaolin; even at the lower levels of the mine the plagioclase has a chalky appearance. Light-gray microcline is more abundant than plagioclase, and is partly intermixed with quartz. The quartz is light gray and glassy, or white and sugary. Pink garnets, in crystals as much as half an inch in diameter, and biotite are relatively scarce. The muscovite is clear ruby.

The pegmatite is irregularly zoned. Mica-bearing zones 1 to 5 feet thick generally occur along both the footwall and the hanging wall, where block mica is irregularly scattered in a matrix of microcline and subor-



MAP AND SECTIONS OF THE LYLE KNOB MINE, MACON COUNTY.

dinate plagioclase and quartz. At the No. 4 level the south-wall mica zone is reported to be the more productive, whereas at the No. 1 level and below it commercial quantities were obtained only from the north side. Pegmatite that consists chiefly of microcline with minor plagioclase and quartz lies next to the mica-bearing zone, and in the upper part of the mine it is the innermost zone of the dike. Where mica-bearing pegmatite is absent, the microcline pegmatite may extend to the walls. A core of massive quartz occurs in the lowest (west) part of the No. 1 stope and in the No. 5 tunnel but is absent from higher levels. It is flanked by microcline zones without any sheet mica.

The other pegmatites in the Lyle Knob area are composed dominantly of plagioclase with minor quartz in small masses and relatively little commercial mica. This type of plagioclase pegmatite is rarely encountered in the main Lyle Knob mine.

MOODY MINE

J. M. PARKER III and W. C. STOLL

The Moody mine, northwest of Franklin, Macon County, was an exceptionally productive mine during part of its history. (See pl. 13.) The forked drift on the south side of the ridge was driven about 1900, but very little mica was obtained. About 1914, Ray and Fouts worked in the weathered part of the main pegmatite to a depth of about 50 feet below the outcrop. Many of these upper workings are caved and no longer accessible. Frank Moody operated the mine successfully for three years about 1917, driving at least two short adits, lower and farther west than Ray and Fouts. Later he drove the lowest adit, 250 feet long, and opened most of the workings at this and lower levels. The mine was then operated without great success by a Philadelphia company in 1920 and 1921, and was idle from 1922 until September 1942. W. E. Grindstaff then reopened it for the Asheville Mica Company, and the operation continued intermittently until late in 1944.

The wall rock is a relatively fine-grained gneiss consisting of quartz, feldspar (mainly plagioclase), biotite, muscovite, and small pink garnets. The gneiss is layered, some bands being schistose, others fine-grained and granitoid. One hundred feet or more from the pegmatite, the gneiss strikes about N.15°E. and dips 50 to 60 degrees northwest, but near it the foliation has been twisted in many directions.

The pegmatite body trends east across the foliation of the country rock. Its strike changes markedly in the middle of the workings, forming a crude, elongate "S" in plan. As traced from the east end, the dike bends from slightly north of west to about S.60°W. in the center, and back to west-northwest at the west end. The average dip from the surface to the lowest workings is 74°.

The pegmatite contains a core of quartz that is nearly ten feet thick at the center of the mine. Between this mass and the walls on either side are feldspathic zones each 4 to 6 feet thick. The central quartz body pinches out to the east in the lower levels so that the hanging-wall and footwall feldspathic zones merge, with a total thickness here of 5 feet or less. The quartz continues to the west as far as the mine has been developed. The quartz mass is cut by many closely spaced shears, especially near its footwall margin, that are approximately parallel to the sides of the quartz mass. They are coated with biotite, as much as 0.2 inches thick, and where the shears are closely spaced, the rock has a schistose appearance.

The feldspathic pegmatite consists mainly of bluish-gray plagioclase and quartz, with muscovite, and a little biotite and garnet. No microcline was observed. Along the walls in many places is a 6- to 8-inch border zone of finer plagioclase and quartz, studded with small mica books one-quarter of an inch to one inch in diameter. Within the feldspathic wall zones mica is concentrated in certain shoots, the richest of which are in contact with the central quartz zone. Where the quartz core is absent, as at the east end of the mine on the lower levels, the mica is cracked and wavy.

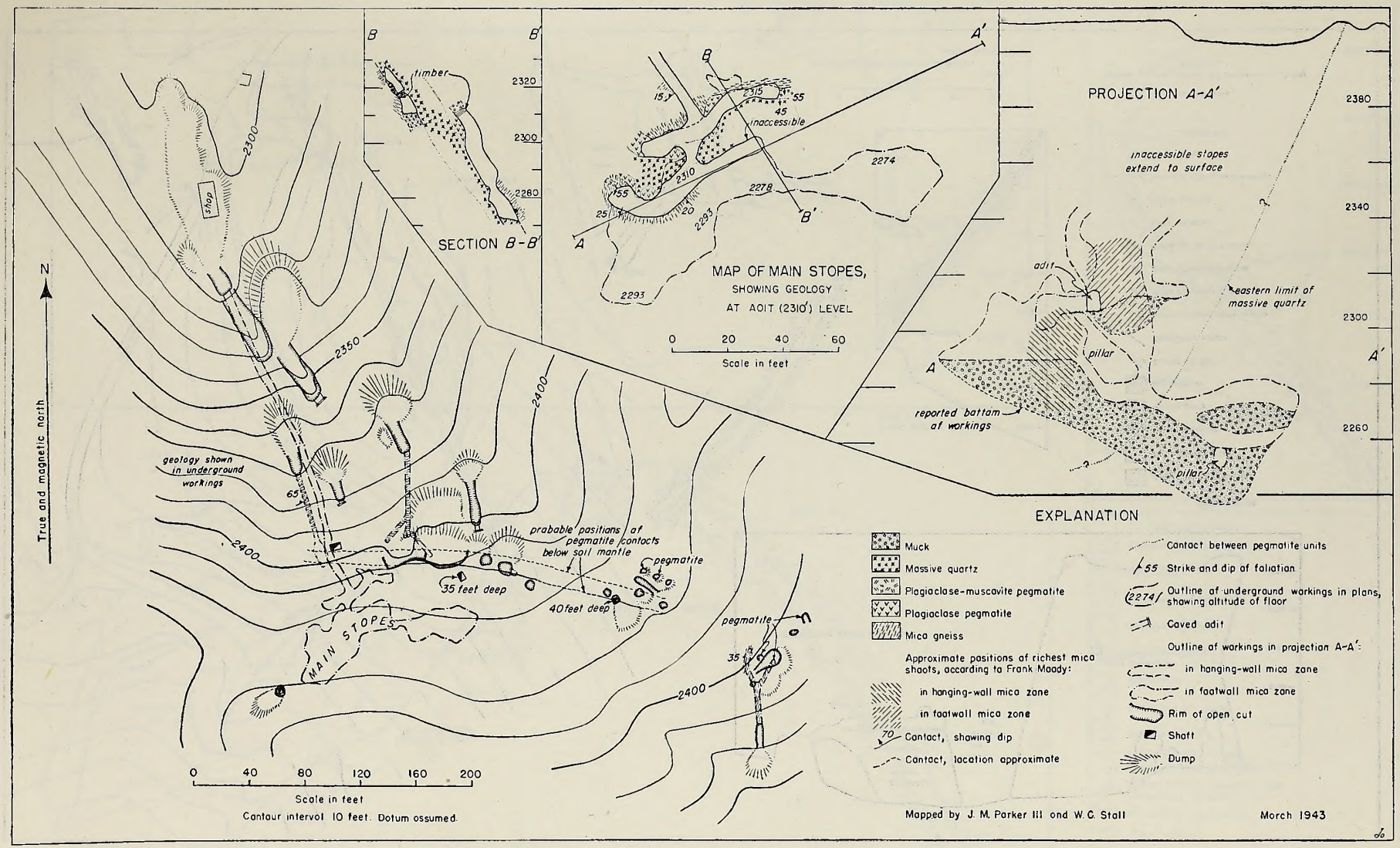
The workings as a whole plunge downward S.55°W. from the surface at an angle of 60°—the probable pitch of the quartz core. It seems likely that the quartz core and the mica shoots are related to the changes in strike of the dike as seen in the accessible underground workings, and possibly also to a decrease in dip of the body at about the adit level.

POLL MILLER MINE

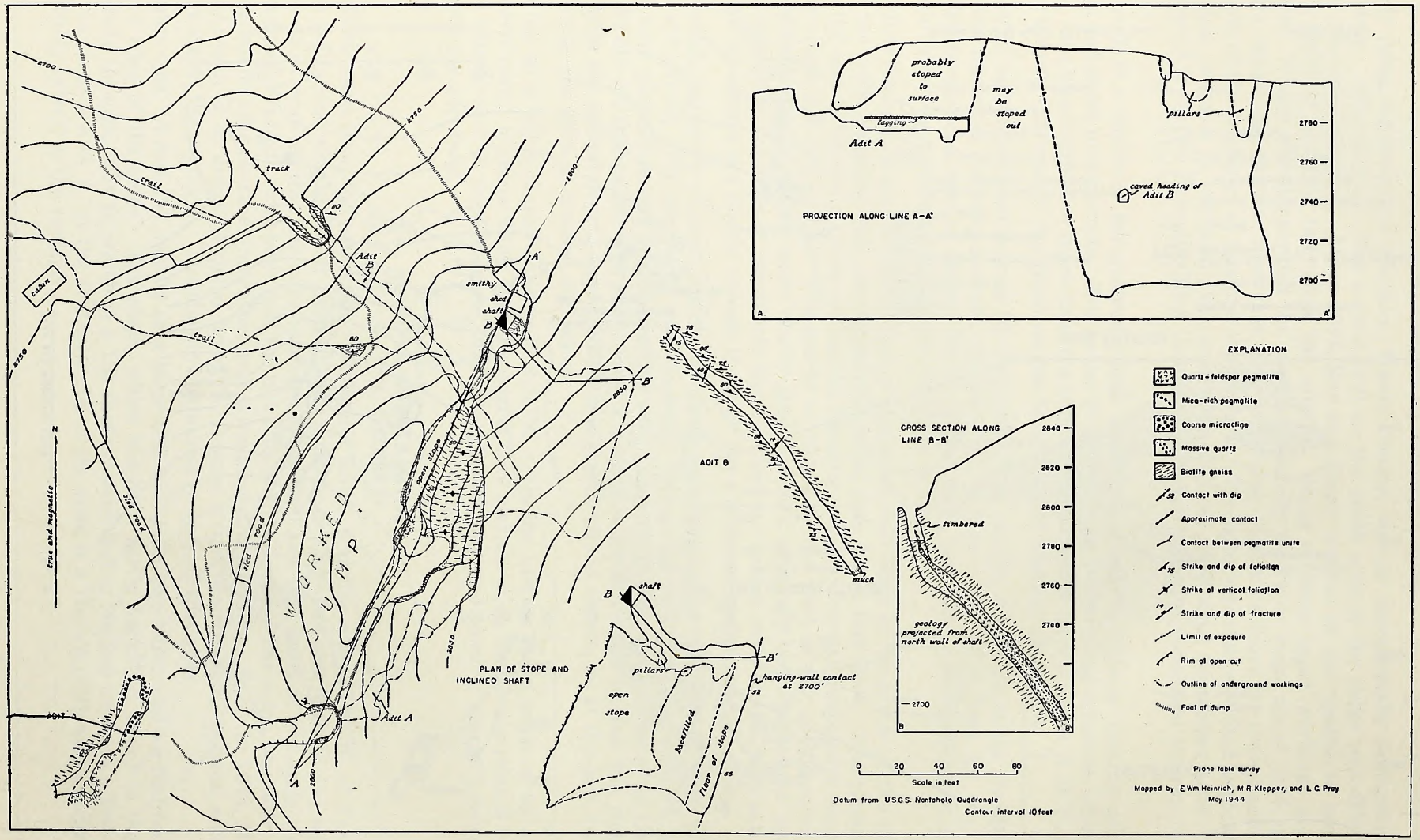
E. WM. HEINRICH

The Poll Miller mine is on the north side of Tremont Ridge, 8 airline miles N.80°W. of Franklin, Macon County. It lies on the east side of Miller Hollow at an altitude of 2,800 feet and is about 1½ miles northeast of Locust Gap. It is reported that the mine was opened in 1900 and that much of the early work was done by Charles Bowers of Franklin, who later sold the mine to a Mr. Clarke. The mine was idle for about 25 years except for minor near-surface operations and reworking of the dumps. Early in 1943, Messrs. Lowell Jamison, Fred Arnold, G. A. Jones, Richard Jones, W. Rogers, Frank Moody, Mark Dowdle, and Henry Cabe of Franklin, purchased the property. They began operations in July of that year.

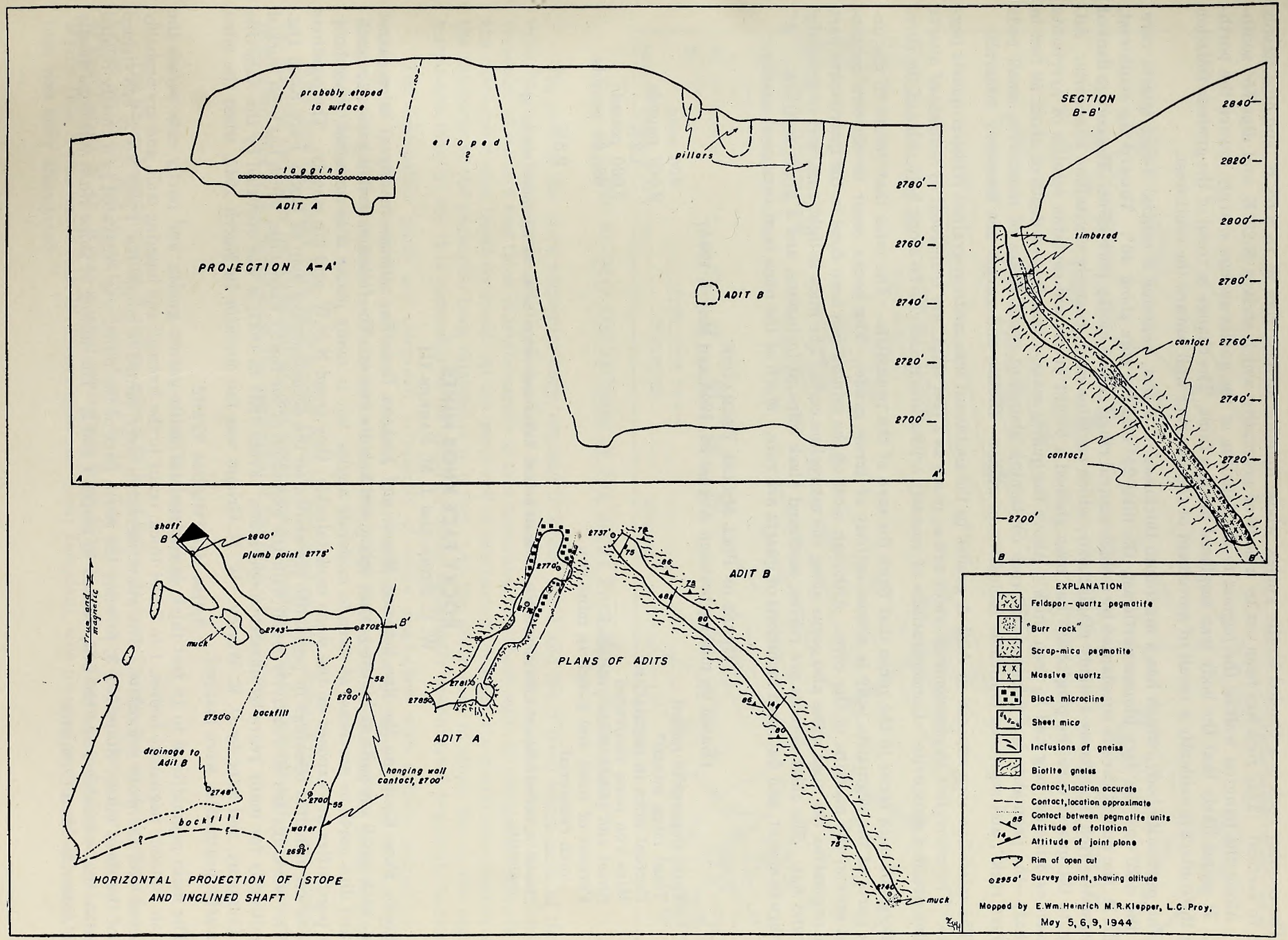
The workings (pls. 14 and 15) consist of a stope 120 feet deep, two adits, and an inclined shaft along the northeastern edge of the stope. The stope, which has been partly backfilled, opens to the surface. It was worked chiefly through Adit B, which is a 150-foot crosscut that is blocked by muck a few feet from its junction with the stope. Adit A, at the southern end of the area, is a 75-foot drift with overhand backfilled stopes that probably extend to the surface.



MAP AND SECTIONS OF THE MOODY MINE, MACON COUNTY.



MAP OF THE POLL MILLER MINE, MACON COUNTY.



UNDERGROUND MAPS AND SECTIONS OF THE POLL MILLER MINE, MACON COUNTY.

The country rock is a banded biotite gneiss, whose foliation strikes from W. to N.65°W. and dips steeply north to vertical. This rock has been cut by a body of pegmatite which strikes N.25°E. and dips 55° southeast. Along the hanging wall of the pegmatite the foliation of the gneiss swings sharply toward the northwest. It seems likely that the body was emplaced along a fault. The change in trend of the gneissic foliation along the contact is evidently a result of movement of the hanging wall toward the southwest.

The pegmatite body, which has a maximum thickness of 8 feet, contains a central 3-foot quartz core. Both the dike and the core plunge northeast, the dike 24° and the core about 40°. Toward the southwest, in Adit A, the quartz core is supplanted by a thick central rib of coarse blocky microcline. The core is flanked by pegmatite rich in feldspar (chiefly plagioclase), which contains much coarsely crystalline muscovite. Adjacent to the quartz core the plagioclase has been stained a bright green and contains veinlets of pyrrhotite as much as 3 inches long and ½ inch thick. Above the quartz mass,—that is, to a depth of about 50 feet in the shaft—the pegmatite is a feldspar-rich rock containing abundant small flakes of muscovite, small pods of "burr rock", and scattered lenticular inclusions of gneiss. Biotite and garnet are accessory minerals.

The microline core exposed in Adit A grades to the southwest into medium-grained feldspar-quartz pegmatite. The microcline blocks, some of which are as much as 2 feet thick, are transected by veinlets of quartz and fine-grained muscovite. Concentrations of coarsely crystalline muscovite lie along both sides of the core.

Books of mica occur in the zones that flank the core of the pegmatite. The mica that occurs in the unzoned parts of the pegmatite body is almost entirely of scrap grade. The books occur in clusters concentrated around the margins of the core. Although most of the mining has been done in the quartz-core part of the pegmatite, the mica zones also occur along the microcline core. The mica is light rum, and is generally hard and flat. The chief defects are reeves, scattered black mineral inclusions, and a green mottling. "A" structure is absent, and flattened inclusions of quartz are rare. Much of the mica is of very good quality.

GRADE OF POLL MILLER PEGMATITE
(Based on mining between August 26, 1943 and May 4, 1944)

Total pegmatite mined	300 tons
Total mica mined*	8,000 pounds
Percent mica in pegmatite*	1.3%
Mine-run mica recovered	7,000 pounds
Sheet and punch mica produced	683.60 pounds
Percent of sheet and punch in mine-run mica recovered	9.8%

*Based on the estimate of 1,000 pounds lost as small broken flakes and larger books in unbroken blocks of pegmatite.

ROCKY FACE KNOB MINES

W. C. STOLL and J. M. PARKER III

Rocky Face Knob, on the line between Macon and Jackson Counties, consists mainly of mica-garnet gneiss, with small amounts of biotite-garnet schist and kyanite gneiss. The foliation strikes generally northwest and dips north or northeast at steep to moderate angles, but in many places it is contorted irregularly. Many pegmatites are exposed on the steep mountainside; they trend N.N.W. and dip steeply. The positions of the seven principal openings in pegmatite are shown on the accompanying map of Rocky Face Knob (fig. 5). The workings are all relatively small with the exception of the Rocky Face mine, which has been worked intermittently for many years by numerous operators. From 1937 to 1941, it was operated by the Asheville Mica Company, and later by D. E. Worley. W. N. Grimm was the operator in March 1943, when the mine and nearby pegmatites were mapped.

The main pegmatite, 6 to 18 feet thick, is enclosed in biotite-garnet gneiss, and partly cuts across the foliation. Smaller pegmatite bodies, 1 to 7 feet thick, occur in the footwall and hanging wall, and are probably connected with the main pegmatite. The main pegmatite body, mined in stopes No. 1 and No. 2, has yielded most of the sheet mica. Stope No. 3, forming the north part of the mine, was excavated in a closely related pegmatite that probably joins the body mined in stopes 1 and 2. The mining of stope No. 3 was done mostly by the Asheville Mica Company.

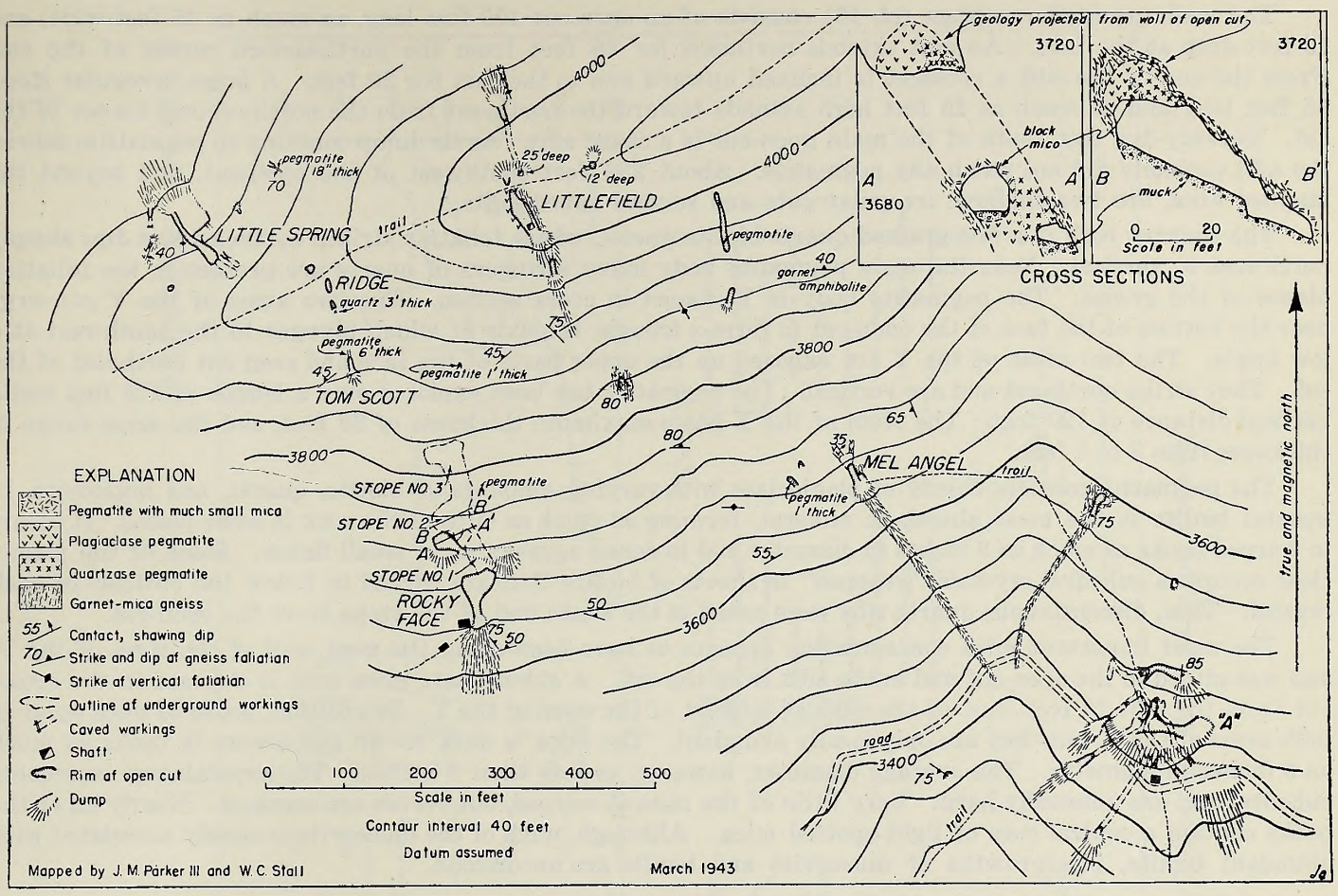


FIG. 5.—MAP AND SECTIONS OF THE ROCKY FACE MINE, MACON COUNTY.

The part of the main pegmatite body, exposed in stopes No. 1 and No. 2 from which most of the sheet mica has come, has a strike length of about 100 feet and a maximum thickness of 18 feet. It consists of an irregular core 3 to 6 feet thick of white sugary quartz, separated from both walls by feldspathic zones in which the commercial mica books occurred. At the north end of this part of the mine, the quartz core pinches out and the thickness of the pegmatite body diminishes to 6 feet. At the south end, in stope No. 1, the pegmatite terminates bluntly, but it is succeeded to the south by other, apparently unconnected pegmatite bodies.

The feldspathic parts are composed principally of white plagioclase with a little microcline, minor amounts of quartz, muscovite, and small garnets. The footwall feldspathic zone is 7 to 11 feet thick; the hanging-wall feldspathic zone is mostly about 3 feet thick, but rarely it is absent and the massive quartz lies next to the hanging wall.

Mica from the Rocky Face mine is clear ruby of very good quality. Some of the sheets are slightly wavy, but staining and other imperfections are not conspicuous. Sheets of relatively large size have been obtained from some mica books mined from the pegmatite of the Rocky Face mine.

SHEEP MOUNTAIN MINE

E. WM. HEINRICH

The Sheep Mountain mine, 7 airline miles S.25°E. of Sylva, Jackson County, lies on the north side of Moses Creek, about 200 feet above the Moses Creek Road. The mine is owned by the Blackwood Lumber Company of East Laport, N. C. It was worked intensively from 1915 to 1918 by Oscar Lovedahl of East Laport. In March 1944 it was leased to J. W. Swayangim and Oscar Lovedahl, who planned to reopen the mine, but this plan was later abandoned.

The main group of workings (pl. 16) consists of an open-cut 100 feet long, as much as 45 feet wide, and 75 feet deep at the face. An adit extends northeast for 65 feet from the northeastern corner of the cut. From the end of the adit a crosscut is inclined upward and to the east for 20 feet. A large, irregular stope 65 feet long and as much as 25 feet high extends toward the northeast from the northwestern corner of the cut. Seventy-five feet south of the main open-cut is a caved adit. As its dump contains no pegmatitic debris, the adit probably did not reach any pegmatite. About 200 feet southwest of the open-cut, and beyond the mapped area, are two shallow, irregular cuts and several caved adits.

The country rock is a fine-grained quartz-biotite gneiss, whose foliation strikes northeast and dips steeply northwest to vertical. Near the main pegmatite body many stringers of quartz are present in the foliation planes of the gneiss. The pegmatite body is Y-shaped in cross section. The two arms of the Y converge near the bottom of the face of the open-cut to form a trough, the axis of which plunges to the southwest at a low angle. The two arms of the Y are exposed on the upper parts of the face and crop out northeast of the cut. They strike northeast and are vertical. The pegmatite has been explored over a length of 170 feet and a vertical distance of 120 feet. The stem of the Y has a maximum thickness of 20 feet, and the arms range in thickness from 3 to 5 feet.

The pegmatite consists chiefly of plagioclase with varying amounts of biotite, quartz, and muscovite. In general biotite is the most abundant mineral, forming as much as 60% of the rock in some places. It occurs in warped books as much as 8 inches in diameter and in dense aggregates of small flakes. Some of the plagioclase occurs as euhedral crystals "wrapped" in sheets of biotite that are curved to follow the outlines of each crystal. Thin, discontinuous quartz ribs were noted in the south end of the stope from the open-cut.

The most important mica concentration appears to have been along the west wall of the stem of the Y, and was mined in the open-cut and in the adit from the cut. A subordinate mica zone is exposed in the crosscut from the adit 10 feet west of the eastern contact of the stem of the Y. In addition, books of mica occur in both arms of the Y, but they are only locally abundant. The mica is dark brown and occurs in books as much as 6 inches in diameter. The average diameter, however, is less than 3 inches. The crystals are commonly euhedral and are unusually hard. Very little of the mica is warped, but reeves are common. Nearly all of the books contain a central core of light-spotted mica. Although much of the muscovite is closely associated with abundant biotite, intergrowths of muscovite and biotite are uncommon.

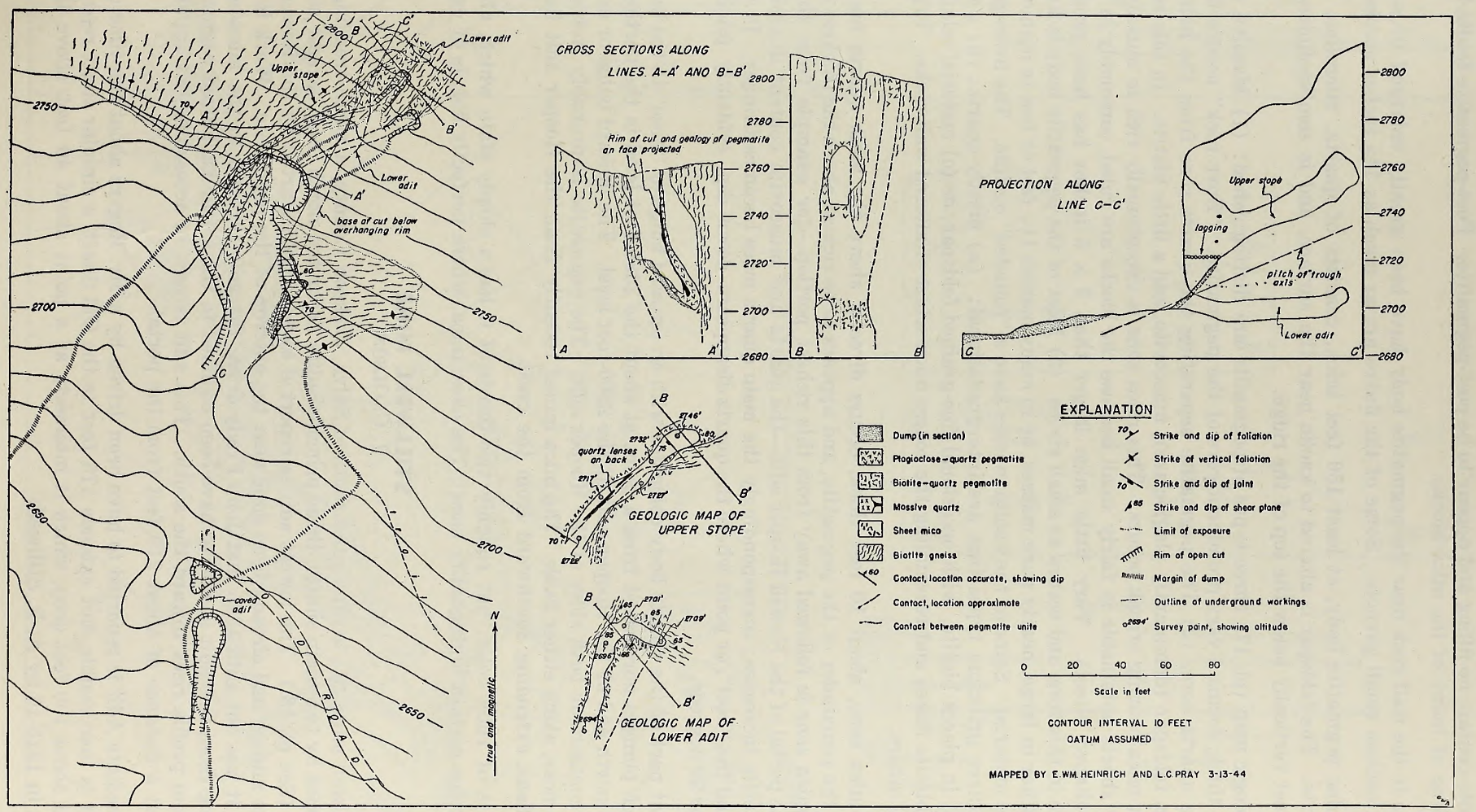
SHEPHERD KNOB MINE

J. C. OLSON

The Shepherd (Boyd) Knob pegmatite trends north across the south side and top of a low ridge which rises about 500 feet above the level of Cowee Creek, a quarter-mile south of the mine, (see pl. 17) 6½ airline miles north of Franklin, Macon County. During the last 20 years it has been one of the largest sources of scrap and sheet mica in the district. Both kaolin and mica were mined as early as 70 years ago from tunnels and pits in soft decomposed pegmatite. Adits, begun near the crest of the ridge, were driven progressively lower on both the south and north slopes of the ridge. The lowest adits north of the ridge, the Bob and "New" adits, were driven about 1917-18; the Bob adit is reported to have been driven through the mountain to the main open-cut. Most of the adits on the north side of the ridge are open and accessible to their intersections with the pegmatite, where they are caved. It is reported that much stoping was done eastward from the ends of these adits along the pegmatite, but very little westward except for a reported 60-foot drift westward from the Bob adit.

Several years after World War I, J. E. Rice installed a plant for the recovery of scrap mica from decomposed pegmatite by washing and screening. This hydraulic mining obliterated many of the older "groundhog" tunnels, and created a large (East) open-cut 350 feet long and as much as 175 feet wide and 75 feet deep, and a smaller (West) open-cut 250 feet long, 50 feet wide, and 25 feet deep. Subsequently, much scrap and some sheet mica have been mined, mostly by J. E. Rickman and by the Asheville Mica Company. Late in 1941, Newell Hooper drove the lowest (Hooper) adit on the south side of the ridge, and mined sheet mica from it until the spring of 1944.

The pegmatite is enclosed in gray mica gneiss, composed dominantly of quartz and feldspar, with garnets and flakes of biotite and muscovite so small that weathered rock shows only very faint foliation. The gneiss is deeply weathered to a yellowish or purplish-brown color, and is cut by joints and small faults. Some of the joints contain pegmatite; others cut both country rock and pegmatite and contain quartz; however,



MAP AND SECTIONS OF THE SHEEP MOUNTAIN MINE, JACKSON COUNTY.

most of the joints contain no filling and appear to be post-pegmatite. Post-pegmatite faults have resulted in a pronounced ruling of many of the mica blocks.

Mica flakes in the wall rock near the pegmatite body have been greatly enlarged by solutions from the pegmatite, and enclose small garnets. Some of the flakes are as much as 1½ inches across.

The irregular pegmatite body, at least 150 feet thick, consists of quartz, microline, plagioclase, muscovite, and biotite. The feldspar is altered to kaolin near the surface, and is semikaolinized in underground workings 140 feet vertically below the top of the ridge.

On the geologic map (pl. 17) three types of pegmatite are distinguished: (1) Massive quartz, in a body at least 20 feet thick, forms a very prominent core of the pegmatite. "Burr rock" occurs in places near the margins of the quartz core. (2) The pegmatite separating the quartz core from the hanging wall is composed of quartz, feldspar (dominantly plagioclase), muscovite, and a little biotite. In this zone, about 10 feet thick, the main mica-bearing streak occurs. This mica zone is exceptionally rich in muscovite, although the average size of sheets obtainable is fairly small because the blocks are ruled, commonly in two directions, to yield diamond-shaped sheets. Very little mica larger than 3 x 5 inches has been produced. Biotite is relatively scarce in this zone and occurs as small strips. (3) Most of the pegmatite body is kaolinized feldspar, which occurs either in large, nearly pure masses, or in many masses 1½ feet or less in diameter and separated by finer-grained material. Some of the kaolin masses have a "rounded" outline. The finer-grained interstitial material is of three principal types that are intergradational: (a) mostly quartz; (b) a mixture of quartz and small mica, in places biotite, with occasional fine-grained feldspar; or (c) material relatively rich in small muscovite and biotite flakes and resembling the coarse mica schist of altered wall rocks. Type *c* is more feldspathic than the others.

The sheet-mica zone, about 10 feet thick, occurs directly above the main quartz mass, is itself more quartzose than the remainder of the pegmatite, and appears to be richest above the thickest part of the quartz body. As the mica zone is followed away from this richest portion—for example from the heading southward toward the portal of the Newell Hooper adit—the quartz and muscovite content diminishes and that of feldspar and biotite increases; correspondingly the main quartz mass becomes thinner. It also becomes thinner down dip, and the "keel", or point where the quartz disappears down dip, evidently pitches northward at an angle of 15 or 20 degrees.

The thickest part of the quartz body coincides with an upward bulge or "nose" in the hanging wall of the pegmatite, which plunges northward from a point at about the 2380-foot level in the northeast corner of the open-cut to the north end of the Hooper adit at the 2300-foot level. The upward bulge or nose is indicated by the attitude of contacts on both sides of the Hooper adit. The pegmatite is probably richest in mica within 200 feet of this nose, along either flank. The mica mined recently from the Hooper adit has come from the crest and the flank extending southward from the crest.

The mica is of ruby color, but roughly two-thirds of it has a cloudy stain which, although not black, renders it unfit for certain high-quality uses. The clear mica, where perfectly flat, is of excellent quality.

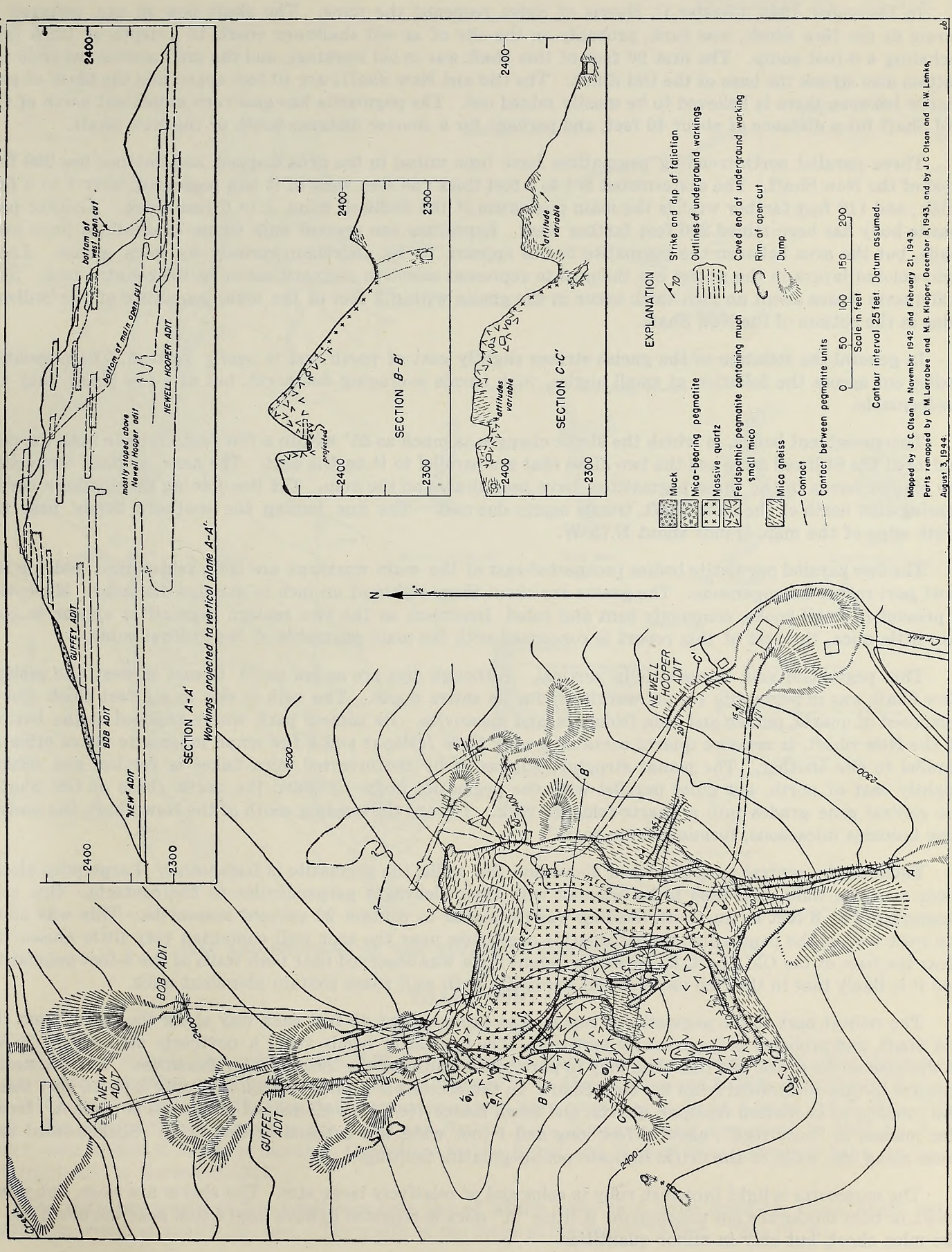
STILLWELL MINE

J. C. OLSON

At the Stillwell mine, 3½ airline miles south of Sylva, Jackson County, a north-trending pegmatite body has been developed by two main shafts, three principal adits from the north, and several smaller adits, pits, and trenches. (See pl. 18.) The lowest adit is reported to have been started by the Bowers brothers about 1875, after some mining had already been done near the outcrop of the pegmatite. Work in this adit was intermittent, and it was not until 1885 that John Frady drove the adit through to the mica-bearing pegmatite. The early mining from this adit is said to have been confined to the softer kaolinized pegmatite, and for that reason its bottom profile rises toward the south. This adit is now in accessible, but apparently intersected the pegmatite at a distance of about 210 feet from the portal.

The Intermediate Adit is reported to have been driven by a Mr. Rogers about the time of the first World War. This adit is inaccessible, but extends 175 feet to the Old Shaft, a circular shaft reported to be 18 feet in diameter and about 100 feet deep, which it intersects at a point about 40 feet above the bottom. This shaft was sunk in 1915-16 by A. R. Stillwell.

BULLETIN 49 PLATE 17



MAP AND SECTIONS OF THE SHEPHERD KNOB MINE, MACON COUNTY.

In December 1943, Chester C. Harris of Sylva reopened the mine. The shaft now in use, referred to herein as the New Shaft, was sunk, probably on the site of an old shallower shaft, to a depth of 122.5 feet, including a 6-foot sump. The first 90 feet of this shaft was in old workings, and the drift northward from the bottom also struck the base of the Old Shaft. The Old and New Shafts are 40 feet apart, and the block of pegmatite between them is believed to be mostly mined out. The pegmatite has also been mined out north of the Old Shaft for a distance of about 40 feet, and perhaps for a shorter distance south of the New Shaft.

Three parallel north-trending pegmatites have been mined in the area mapped, and another lies 200 feet west of the New Shaft. The easternmost is 1 to 2 feet thick; 35 feet west of it is a pegmatite body 1 to 3 feet thick; and 110 feet farther west is the main pegmatite of the Stillwell mine, 1 to 6 feet thick. Another pegmatite body has been mined 200 feet farther west. Exposures are present only where excavations have been made, but the area between the pegmatite bodies appears to be underlain entirely by mica gneiss. Local light-colored layers in the gneiss are thought to represent selective pegmatitization of the country rock. Several quartz lenses about an inch thick occur in the gneiss within 3 feet of the main pegmatite of the Stillwell mine at the bottom of the New Shaft.

In general the foliation of the gneiss strikes slightly east of north and is nearly vertical. The pegmatite bodies cut across the foliation at small angles, with trends averaging due north, but at a few places they are conformable.

Two prominent bends, in which the strike changes as much as 35° within a few feet, occur in both the pegmatite at the Stillwell mine and the two dikes that are parallel to it on the east. The axes, or lines connecting the similar bends in the three pegmatites, have been drawn on the map. The line joining the northern bends, passing just north of the New Shaft, trends nearly due east. The line joining the southern bends, near the south edge of the map, trends about N.75°W.

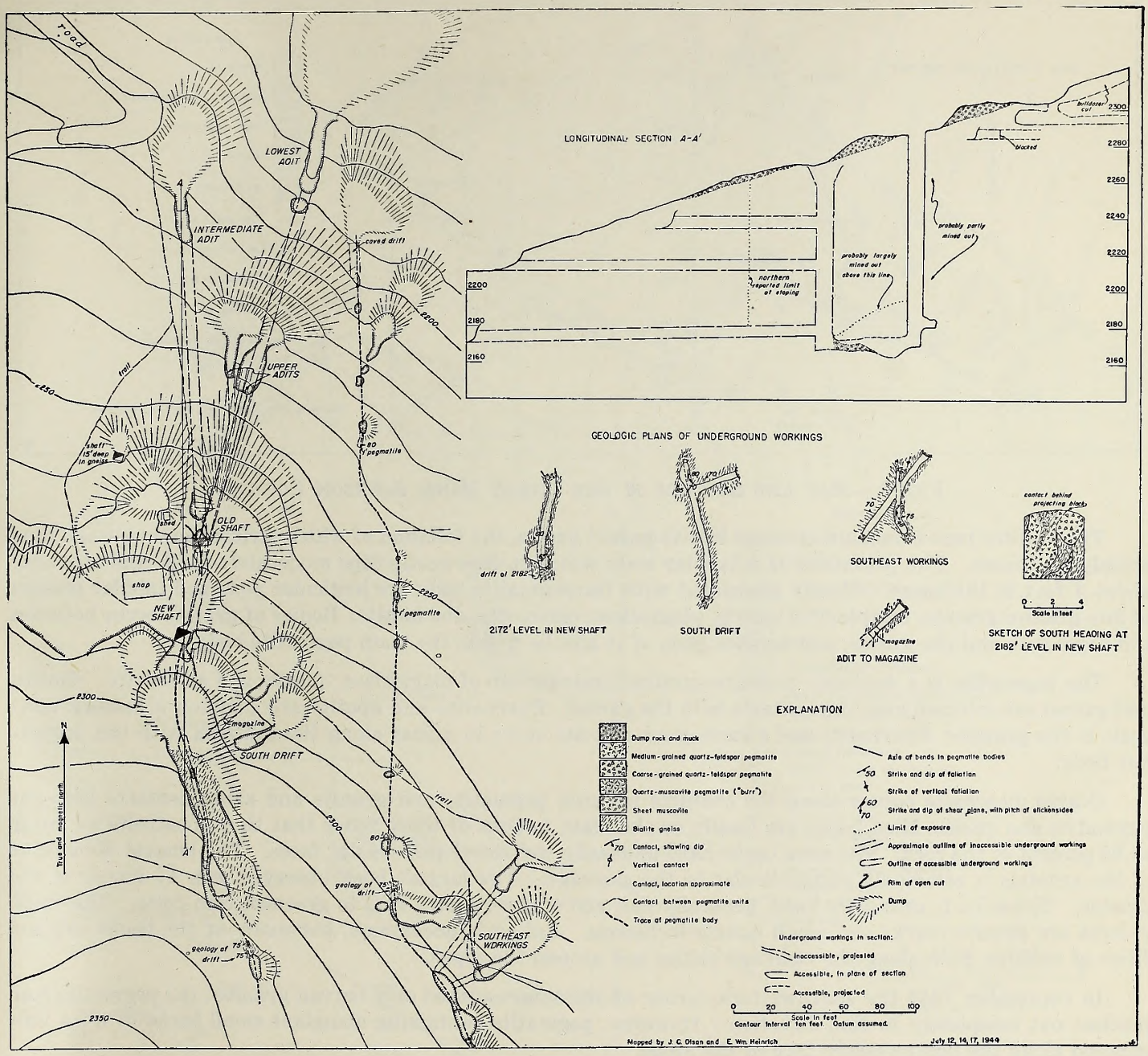
The two parallel pegmatite bodies prospected east of the main workings are thin, feldspathic, and for the most part rather homogeneous. The grains are about three-eights of an inch in average diameter. Muscovite is present in small books, commonly bent and ruled. Inasmuch as the two eastern pegmatites appear to contain little mica, the rest of this report is concerned with the main pegmatite of the Stillwell mine.

This pegmatite vein is essentially vertical. Although dips are as low as 70° to east or west, the vertical New Shaft was in pegmatite (or old workings) for its entire depth. The vein is one to six feet thick and is composed of quartz, potash and soda feldspars, and muscovite. Its central part, where exposed at the bottom of the New Shaft, is massive quartz containing very little feldspar and a few small muscovite flakes oriented parallel to one another. The planar structure suggested by the oriented mica flakes is vertical and strikes slightly east of north, not quite parallel with the pegmatite body. Toward the north (base of Old Shaft) the central zone grades into a quartz-feldspar rock. Toward the heading south of the New Shaft, the central zone becomes micaceous, forming "burr rock."

Between the central zone described above and the walls, the pegmatite is feldspathic. Large mica blocks occur near the walls, and tend to be oriented with their cleavages perpendicular to the contacts. One area measuring 2 by 6 feet in the south heading was estimated to contain 20 percent muscovite. This was along the west wall of the pegmatite; the feldspathic pegmatite near the east wall contained very little muscovite. Near the base of the Old Shaft, however, abundant mica was observed near both walls of the 5-foot pegmatite, and it is likely that in the rich parts of the pegmatite both wall zones contain abundant mica.

The richest part of the pegmatite is reported to extend about 40 feet each way along the strike from the Old Shaft, and probably plunges nearly vertically. The pegmatite bends from a northerly strike to N.35°W. at the base of the shaft, and this bend may in part be the cause of the local greater thickness. The pegmatite appears to thin southward from the New Shaft. In the accessible shallow drifts, it is only 2 to 2.5 feet thick, and consists of kaolinized feldspar, quartz, and small muscovite. No well-defined mica zone is present. Irregular masses of "burr rock", about 6 feet long and 1 foot wide, are exposed in this drift. Slicken-sided surfaces along the walls of the drifts indicate post-pegmatite faulting.

The muscovite is light brownish ruby in color and of relatively large size. The sheets are clear, but wavy, ruled, or bent blocks are not uncommon. A little "A" mica is reported to have been found near the north end of the mica shoot, but only in minor quantities.



MAP AND SECTIONS OF THE STILLWELL MINE, JACKSON COUNTY.

TILLEY MINE

E. WM. HEINRICH

The Tilley mine is 10.3 airline miles N.55°E. of Franklin, Macon County. It lies near the top of the steep ridge between Panther and Sheep Knobs. It was mapped by D. M. Larrabee and E. Wm. Heinrich on January 17, 1944. On September 25, 1944 the underground workings were remapped by R. W. Lemke and E. Wm. Heinrich. The mine, which is owned by the Rubin and Hetkin Mica Company, was discovered in 1935 by R. F. Tilley, who worked it for three months. Operations by the Rubin and Hetkin Mica Company have continued intermittently to the end of 1944.

The workings consist of five small open-cuts, one of which leads to a large down-dip stope which has a maximum length of nearly 200 feet. The width of the stope at the face is 75 feet. (See fig. 6)

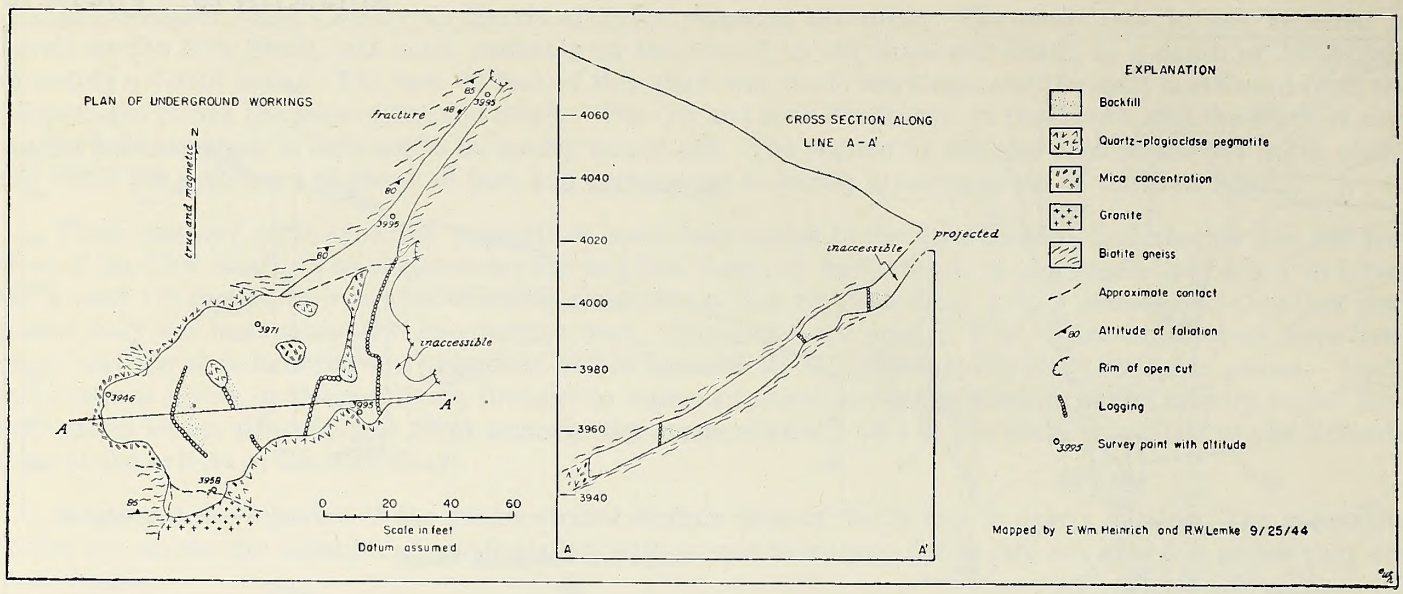


FIG. 6.—MAP AND SECTION OF THE TILLEY MINE, JACKSON COUNTY.

The country rock is medium-grained biotite-garnet gneiss, the foliation of which strikes northeast and dips steeply southeast. The pegmatite is a tabular body which strikes north, dips moderately west, and averages about 4 feet in thickness. Closely associated with the pegmatite body are lenticular pods and tabular masses of fine-grained granite, composed of quartz, plagioclase, muscovite, and biotite. Bodies of granite occur between the pegmatite and the gneiss, and smaller pods of it also lie within the main pegmatite body.

The pegmatite is a medium- to coarse-grained intergrowth of plagioclase, quartz, and muscovite. Biotite and garnet are common near the contacts with the gneiss. Pyrrhotite and apatite are common accessory minerals in the granite. Pyrrhotite and a dark-green chlorite occur in gneiss along the contacts with the pegmatite body.

Coarse muscovite occurs along the contacts between pegmatite and granite and along contacts between pegmatite and gneiss. Mica books are locally so abundant in both of these zones that they constitute as much as 50 percent of the rock. The mica books have unusually well-developed crystal faces. The longest dimension of the crystals is commonly perpendicular to the cleavage. The largest book observed was 14 inches in diameter. The mica is unusually hard, generally flat, and of a very dark rum to greenish rum color. The chief defects are minute cracks and small quartz inclusions. Ruling is uncommon, but many of the books contain films of sulfides, both along the cleavage planes and around the edges.

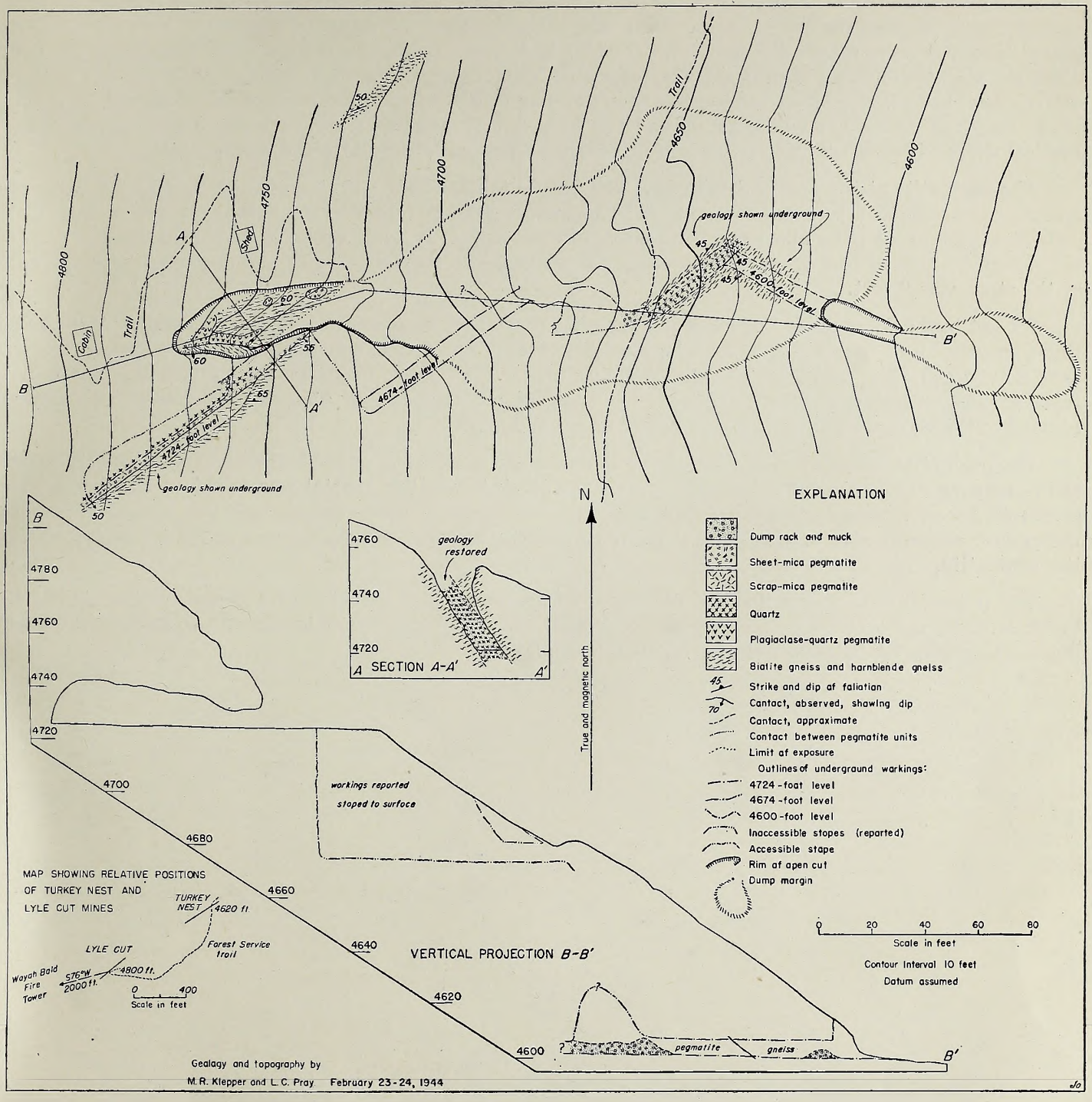
In September 1944 the southwestern corner of the stope exposed only barren granite; the pegmatite had pinched out completely in this direction. However, pegmatite containing abundant small books of mica was exposed along the northwestern face of the stope.

TURKEY NEST AND LYLE CUT MINES

M. R. KLEPPER

The Turkey Nest and Lyle Cut mines are on the south side of a high ridge about a mile east of Wayah Bald. The Turkey Nest mine (pl. 19) has been operated intermittently for the past nine years by J. L. Barnard of Franklin. In 1944, work was proceeding in the upper (west) drift. Information regarding the old workings in the eastern two-thirds of the area mapped is not available. According to Mr. Barnard these were probably mined forty or fifty years ago.

The pegmatite at the Turkey Nest mine is enclosed in biotite gneiss which strikes from N.70°E. to east and dips 45-65°N. The pegmatite body strikes N.53°E., dips 45-60°S., and is about 7½ feet thick on the average. It is well zoned, consisting of a central tabular mass of quartz 3 to 5 feet thick flanked on each side by mica-bearing pegmatite 1.5 to 2.5 feet thick. The mica-bearing pegmatite is a medium- to coarse-grained



MAP AND SECTIONS OF THE TURKEY NEST MINE, MACON COUNTY.

aggregate of gray plagioclase (oligoclase?) quartz, and muscovite. Part of the muscovite occurs as small scrappy books intergrown with quartz and feldspar, and part as larger books distributed here and there throughout the zone. The new drift and stope expose only the part of the pegmatite body between the quartz core and the hanging-wall gneiss, which, according to Mr. Barnard, contains a higher concentration of mica than the footwall zone. The quality of the footwall mica, however, is reported to be somewhat the better. The mica is rum or ruby colored, and part of it has "A" structure. An estimated half is black specked.

It seems likely that the Turkey Nest explores the same pegmatite body as the Lyle Cut mine, which lies about 500 feet to the southwest and is strikingly similar in structure and mineralogy. The Lyle Cut mine

was first operated by Dr. J. M. Lyle about 1870. It was then operated intermittently and on a small scale by various operators until the end of World War I, when General Mica Company, of Baltimore, took over and operated for about three years. Philip S. Hoyt and Will McKinney each operated for a short time during 1941 and 1942, and Gilmer Jones, a Franklin attorney, operated the mine from March to October 1943. It has been inactive since then. The pegmatite body has been developed by (1) a tabular open-cut and stope having a maximum length of 225 feet, a maximum depth of 85 feet, and an average width of about 5 feet, (2) a 23-foot vertical shaft with a short drift at the bottom, (3) a 20-foot adit, and (4) a few shallow pits.

The pegmatite at the Lyle Cut mine is a well-defined tabular body. It strikes N.50°E., dips 60° to 65°SE. and averages 4½ to 5 feet in thickness. The pegmatite body narrows to the southwest and is only 12 to 14 inches thick in the pillar above the lower entry into the stope. It seems probable that the pegmatite pinches out within a hundred feet or less southwest of the entry. The maximum thickness measured between walls of the stope was 9 feet.

Except in the entry pillar, the exposed pegmatite consists of a tabular quartz core, generally 1½ to 3 feet thick, sheathed by 1 to 2½ feet of mica-bearing pegmatite. The quartz core has a distinctive streaky appearance that more or less parallels the walls of the pegmatite. Alternate bands are gray and milky, and a little feldspar has crystallized in some bands. The appearance suggests that the quartz may have been sheared parallel to the walls near the end of the period of crystallization.

The pegmatite is a medium-to coarse-grained aggregate of milky to gray plagioclase (oligoclase?), quartz, and muscovite. Biotite occurs sparingly. One small black tourmaline crystal was found on the dump. The muscovite occurs as small, scrappy intergrowths with quartz and feldspar and as scattered books. In general the greater concentration of muscovite is reported to occur between the quartz core and the hanging wall of the pegmatite.

The pegmatite has been intruded into fine- to medium-grained garnet-biotite gneiss, which strikes between N.65°E. and east, and dips between 50° and 65°NW. White feldspar metacrysts accentuate the layering of the gneiss. A little hornblende occurs in some layers.